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SMITT. SCANDINAVIAN FISHES

A HISTORY OF

SCANDINAVIAN FISHES

BY

B. FRIES, C. U. EKSTRÖM, AND C. SUNDEVALL

WITH COLOURED PLATES

BY

W. VON WRIGHT

AND TEXT ILLUSTRATIONS

SECOND EDITION

REVISED AND COMPLETED BY

PROFESSOR F. A. SMITT

MEMBER OF THE ROYAL SWEDISH ACADEMY OF SCIENCE

TEXT

PART I

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PREFACE.

When I was commissioned by the publishers to revise and complete in a systematic form "*Scandinavian Fishes*," the work brought out by FRIES, EKSTRÖM, and SUNDEVALL, with drawings by v. WRIGHT, I was not unaware of the great difficulties associated with such an undertaking. Their original plan was to embody in a popular form the results of scientific investigation, and with the most accurate drawings of living specimens to represent the appearance and characteristics of the fishes. As far as the work proceeded, it gained a world-wide reputation as one of the best productions of its kind. But it was interrupted, and neither artists nor writers of the same note as the original ones could be found to continue it. v. WRIGHT's still unrivalled pencil and brush had been laid aside long before his death in 1888; and only a writer of the greatest self-confidence would without hesitation have come forward to submit his work to the test of comparison with what the power of observation and description of FRIES, EKSTRÖM, and SUNDEVALL had already accomplished in the same field of science. However, the Academy of Science was found to possess several hitherto unpublished drawings of fishes executed by v. WRIGHT, and to the collections of the Royal Zoological Museum I had caused to be added quite a considerable number of figures of fishes belonging to the Scandinavian fauna, which might be of service in the continuation of the work. In the Royal Museum are also preserved both the original specimens described in the former edition and the fishes collected by FRIES and SUNDEVALL with a view to the completion of their task. In recent years, too, ichthyology has not been without diligent and distinguished investigators even in Sweden: the names of S. NILSSON, A. W. MALM, and V. LILLJEBORG are widely known and renowned. The piscine faunæ of Norway and Denmark have also been subjected to exhaustive research: during the time that has elapsed since the first publication of "Scandinavian Fishes," ESMARK and COLLETT, KRØYER, LÜTKEN, and WINTHER have all been enrolled among the most eminent ichthyologists, and have rendered this department of zoology quite as thoroughly known in Scandinavia as it is in other lands. With confidence in the value of the material at my disposal, I overcame my hesitation, and ventured to accept the invitation of the publishers to bring out this new edition of one of Sweden's finest national works in the province of literature. But one more difficulty remained, a difficulty which has considerably delayed the appearance of the work in print. Remembering the favourable reception granted to the first edition in other countries, the publishers were desirous to render the new edition also available to the reader who does not know any of the Scandinavian languages, and therefore decided that the work should be also published in English. This difficulty could not be overcome until the publishers succeeded in procuring the valuable aid of Mr. D. LLOYD MORGAN, *B. A.*, Lecturer at the University of Lund, to whom alone it is due that the English edition is fully on a par with the Swedish.

The plan of the work has been the following: in the first place v. WRIGHT's drawings have been reproduced, and where coloured figures, drawn from living or perfectly fresh specimens, have existed among the collections of the Royal Zoological Museum or where such figures could be procured from other sources, these figures are also given, printed in colours and executed with the greatest accuracy attainable in this country. These figures have been lithographed and printed at the *Lithographic Press of the Swedish Ordnance Survey*. In the case of the species of which such drawings could not be procured, or where the species in question is not of essential importance either in the Scandinavian fauna or from an economical point of view, zincotypes, cast at the same establishment, are inserted in the text, from drawings, executed with all possible accuracy, of the specimens preserved in spirits in the Royal Museum or of those which have been kindly lent me by other museums. Most of these drawings have been executed under my supervision by CARL ERDMANN, an artist whose early loss to science and art must be deeply regretted.

I have observed a similar rule in my revision of the text. Of the two hundred piscine species that belong to the Scandinavian fauna, sixty-four were included in the former edition. In every case where the requirements of modern science have not seemed to call for any alteration in the work of my predecessors, I have suffered it to remain untouched. I leave the reader to judge with what success I have endeavoured to follow them in their labour of general instruction. My hopes of producing a handsome work have been grounded on the unsparing generosity of the publishers and the prominent rank occupied by their office in the department of typography; and I have no doubt that an impartial judgment will give them full recognition.

F. A. SMITT.

Stockholm, 1892.

CONTENTS.

Classis: **Pisces.**

Ordo: PISCES TELEOSTEI pag. 1.
Subordo: **Teleostei Physoclysti** 1.
Phalanx: **Physoclysti Eleutherognathi** » 2.
Cohors: **Eleutherognathi Acanthopterygii** » 2.
Divisio: *Eleutherognathi Pharyngognathi* » 2.
Series: *Labromorphi* 2.
Familia: *Labridæ* 3.
Divisio: *Eleutherognathi Lysipharyngei* » 23.
§: *Idiopteri* 24.
Series: *Percomorphi* 25.
Familia: *Percidæ* 25.
» *Sciænidæ* » 49.
Sparidæ 52.
Mullidæ 61.
Berycidæ 66.
Series: *Scombromorphi* 69.
Familia: *Bramidæ* 70.
Carangidæ 82.
Scombridæ 89.
Xiphiidæ 116.
Lamprididæ 121.
§§: *Anomalopteri* 126.
Series: *Trachinomorphi* 127.
Familia: *Trachinida* » 127.
» *Batrachidæ* » 133.
» *Lophiidæ* » 136.
Series: *Cottomorphi* pag. 146
Familia: *Scorpænidæ* 147
Cottidæ 156
Agonidæ 202
Series: *Blennomorphi* 211
Familia: *Blenniidæ* 212
Anarrhichadidæ 231
Series: *Gobiomorphi* » 239
Familia: *Gobiidæ* » 240
» *Callionymidæ* » 271
Cyclopteridæ 282
Gobiesocidæ 300
Series: *Cyttomorphi* » 304
Familia: *Cyttidæ* 305
Series: *Trachypteromorphi* » 309
Familia: *Trachypteridæ* » 309
Series: *Mugiliformes* (*Cestreiomorphi*) » 327
Familia: *Mugilidæ* 328
Cohors: **Eleutherognathi Malacopterygii** 341
Series: *Synentognathi* (*Belonomorphi*) 342
Familia: *Scombresocidæ* 343
Series: *Heterosomata* (*Psettomorphi*) 361
Familia: *Pleuronectidæ* 366
Series: *Onomorphi* 461
Familia: *Gadidæ* 463

INDEX.

Abdominales, Acanthopterygii 24.
abyssorum (Gadus, Lota, Molva), 521.
acadianus (Glyptocephalus), 379.
Acanthocottus, 168, 169.
Acanthocybium, 90, 116.
Acantholabrus, 4, 5.
acanthopteri, Heterocormi, 24.
Acanthopterygii, 2.
Acerina, 40, 25.
aculeatus (Clinus, Leptoclinus, Stichæus, Lumpenus), 228.
aculeatus (Rhombus), 398, 434.
Acus, 347.
acus (Belone), 343, 347.
acuta (Perca), 27.
acutus (Exocoetus) 355.
Æglefinus, 466.
æglefinus (Gadus, Melanogrammus, Merlangus, Morrhua), 465, 466, 467, 484.
affinis (Beryx), 68.
affinis (Cottus), 170.
affinis (Thynnus), 93.
Agassizii (Brama), 81.
Agassizii (Callionymus), 271.
agilis (Gadus) 484.
Agonidæ, 126, 202.
Agonopsis, 204.
Agonostoma, 328.
Agonus, 146, 204.
Aigle, 468.
Aiglefin, 468.
Aigrefin, 466.
alalonga (Thynnus), 91.
albicora (Thynnus) 91.
albidus (Gadus), 540.
Albicore, 97.
Alburnus lucidus, 33.
alburnus (Menticirrus, Umbrina), 120.
albus (Gobius, Latrunculus), 266.
albus (Merlangus), 511.
algeriensis (Batrachus), 135.
allitteratus (Euthynnus, Scomber), 91, 93.
altivelis (Trachypterus), 314, 309.
americana (Morone, Roccus), 44.
americana (Morrhua), 473.
americana (Perca), 27.
americanum (Amphiprion, Polyprion), 47, 48.
americanus (Brosmius), 562.
americanus (Limanda, Pleuronectes), 362, 363, 390.
Ammodytes, 461.
Ammodytidæ, 462, 557.
amphibius (Salarias), 212.
Amphiprion, 48.
Anabas 240.
Anacanthini, 371, 461.
Anacanthini gadoidei, 461.
Anarrhichadidæ, 126, 231.
Anarrhichas, 137, 211, 231
Ancylodon, 51.
Anglepiga, 391.
Angler, 138.
anglorum (Lumpus), 294.
Anomali, 24.
anomalopteri, Acanthopterygii, 24, 126.
Anon, 466.
antarctica (Sciæna), 51.
Antennarii, 136, 144.
Antennarius, 144.
Anticitharus, 426.
Antimora, 539.
Aper (Labrus), 7.
Aphya, 242, 264.
aphya (Gobius), 251, 262.
Aphyonus, 462.
Apodes, 461.
aquila (Cheilodipterus, Sciæna), 50, 51.
araneus (Trachinus), 128.
Archagonus, 206.
arctica (Liparis), 287.
arcticus (Chironectes), 146.
arcticus (Gymnetrus, Gymnogaster, Trachypterus), 315.
argentatus (Merlucius), 514, 515.
argenteolus (Gadus, Motella, Couchia), 550, 553, 554, 556.
argenteus (Gadiculus, Gadus), 464.
argenti-vittatus (Thynnus), 91.
Argyropelecus hemigymnus, 305.
armatus (Aspidophorus), 208.
armatus (Caranx), 85.
Arnoglossus, 363, 426, 427, 428.
arnoglossus (Pleuronectes, Rhombus), 428, 429.
Ascanii (Blenniops, Blennius, Carelophus), 218.
Ascanii (Gymnetrus), 322.
Asellus, 472, 518.
asper (Limanda, Pleuronectes), 390.
aspera (Lepidotrigla), 195.
Aspicottus, 187.
Aspidophoroides, 203.
Aspidophorus, 204.
Atheresthes, 408.
Atherina, 265.
Atherinidæ, 327.
Aurata, 41.
aurata (Sparus), 53.
auratus (Mugil), 333, 337.
aurea, var. (Perca), 30.
australe (Amphiprion), 48.
australis (Brama), 77.
australis (Zeus), 306, 308.
Auxis, 99, 107.
Backeljaune, 476.
Backeljo, 476.
bahiensis (Exocoetus), 358.
Balistes, 2, 137.
Ballan (Labrus), 7.
baltheatus (Thynnus), 91.
baltica, var. (Pleuronectes), 393.
balticus (Hemiramphus), 345.
Banksii (Gymnetrus, Regalecus), 323.
barbatus (Batrachus), 135.
barbatus (Gadus), 473, 479, 493.
barbatus (Liparis), 287.
barbatus (Lophius), 139.
barbatus (Mullus), 62.
barbatus (Rhombus), 441.
Barbel, Sea, 61.
Barbus, 540, 558.
Barracuda, 327.
Bartel, 540.
Bartelfisk, 539.
Batrachidæ, 126, 133.
Batracocephalus, 558.
Batrachus, 134.
Baudroies, 136.
Beanii (Limanda, Pleuronectes), 390.
Behnii (Hemiramphus), 345.
belone (Belone, Esox, Rhamphistoma), 347.
Belonidæ, 343.
Beloninæ, 344.
Belonini, 342.
Bergabborre, 151.
Bergflundra, 385.
Berggalt, 7, 10.
Berggylta (Labrus), 4, 6, 7, 10.
Berghvarf, 456.
Bergnäbba, 14.
Bergsimpa, 173.
Bergskädda, 383, 385.
Bergsnultra, 10.
Bergstubb, 257.
Bergtorsk, 477.
Bergtunga, 375.
Bergulke, 190.
Berycidæ, 25, 66.
Beryx, 66.
Bib, 493, 498.
bicornis (Cottus), 165, 166.
bifurcus (Gadus), 540.
bilinearis (Merlucius), 120, 516.
bilineatus (Orcynus), 89.
bimaculata (Acara, Labrus, Sciæna), 11.
bimaculatus (Cyclopterus, Lepadogaster), 302.
bipunctatus (Gobius), 251.
Birkelånga, 524.
bison (Aspicottus), 187.
bisus (Scomber), 108.
Blågomá, 238.
Blankesten, 59.
Blanksej, 506.
Blenniidæ, 126, 212.
Blenniini, 212.
blennioides (Batracocephalus), 559.
Blenniops, 217.
Blennius, 211, 212, 213.
Blennoidea, 211, 212.
blennoides (Gadus, Phycis), 539, 540.
Blennomorphi, 126, 211.
Blennus, 212.
Blenny, Butterfly, 212.
Blenny, Crested, 219.
Blinds, 493.
Blochii, (Trigla), 197.
Blue-mouth, 155.
Blåa hafkatten, 237.
Blågunnar, 512.
Blåkäften, 154.
Blåskal, 14.

Blåsnultra, 10.
Blåstak, 14.
Blåstål, 14, 272.
Blåstrål, 14.
Bläckfisk, 561.
Boca negra, 155.
Bogdanovii (Pleuronectes), 399, 400, 403.
Bogmarus, 315.
bogmarus (Trachypterus), 315.
Bogini, 53.
Bola, 50.
Boleophthalmus, 240.
Bonaparti (Cybium, Pelamys), 103.
Bonit, 95.
Bonito, 95.
Bonito, Plain, 108.
borealis (Batrachus), 135.
borealis (Beryx), 67.
borealis (Pleuronectes), 392, 396.
Boreogadus, 484.
Boscii (Lepidorhombus, Pleuronectes), 447.
Botargo, 333.
Bothina, 371, 425.
Bothragonus, 203.
Bothus, 426, 432.
Botta, 441.
Bottengnidare, 30.
Bottenmus, 208, 211.
Brachirus, 371.
brachypterus (Thynnus), 91, 98.
Brama, 70, 72, 75, 106.
brama (Cantharus), 54.
brama (Pterycombus), 73.
Bramidæ, 70, 309.
Brandy-fish, 376.
Brandtii (Cottus), 181.
brasiliensis (Thynnus), 93.
Bream, Black Sea, 54.
Bream, Common Sea, 59.
Bream, Rasch's Sea, 80.
Bream, Ray's Sea, 77.
Bream, Spanish Sea, 58.
Bredtorsk, 493.
Bregmaceros, 463.
brevipinnis (Thynnus), 91, 93.
brevirostris (Scombresox), 352.
Brevorti, (Brama), 81.
Brill, 441.
Brill, Turbot-like, 445.
Brismak, 562.
Brosmiinæ, 464.
Brosme, 562.
brosme (Brosmius, Gadus), 562.
brosme (Centronotus), 218.
brosmiana (Lota), 532.
Brosmius 464, 562.
Brosmus, 562.
Brotulina, 463.
Brunsnultra, 5.
bubalis (Cottus, Enophrys), 169, 187, 192.
budegassa (Lophius), 139.
Buckhorn, 491.
Bullerflundre, 403.
Bullhead, Alpine, 173.
Bullhead, Armed, 208.
Bullhead, River, 170.
Burbot, 532.
Butirinus, 1.
Butta, 432, 441.
Butte, 432, 441.
Byrkelange (Gadus, Lota, Molva), 521.
Cabeljou, 479.
Cagnota, 213.
Calimande, grande, 451.
callarias (Gadus), 462, 464, 465, 467, 472.
Callionymidæ, 271.
Callionymini, 271.
Callionymus, 271.
Callyodon, 6.
Camperii (Scombresox), 353.
canadensis (Lucioperca, Stizostedium), 37.
Cantharini, 53.
Cantharus, 53.
cantharus (Sparus), 54.
Cantrainii (Ramphistoma), 349.
Capelan, 497.
capensis (Gymnetrus), 323.
capensis (Trigla), 202.
capensis (Zeus), 308.
capitatus (Cottus), 170.
capito (Mugil), 333, 334, 338, 339, 340.
Capridæ, 70.
Carangidæ, 70, 82.
Caranx, 84.
carbonarius (Gadus, Merlangus, Pollachius), 500.
cardina (Pleuronectes, Rhombus), 453.
Cardine, 447.
Carelophus, 217.
carneus (Labrus), 10.
Carpenteri (Onos), 544.
Carter, 447.
casurus (Pleuronectes), 428.
cataphracta (Trigla), 195.
cataphractum (Peristedium), 195.
cataphractus (Agonus, Aspidophorus, Cottus), 204, 207, 208.
caudacuta (Motella, Rhinonemus), 545.
Cefalo, 331.
Centridermichthys, 157, 162.
centrodontus (Pagellus, Pagrus, Sparus), 56, 57, 59.
Centrolabrus, 4.
Cephalacanthus, 24.
cephalus (Mugil), 333, 334, 340.
Cepolidæ, 211.
Ceratocottus, 187.
cernium (Polyprion), 48.
cernua (Acerina, Perca), 41.
Cestreus, 328.
Chænomugil, 328, 333.
Chætodon, 24.
Chætodontidæ, 71.
Characinidæ, 66.
Chelidon, 356.
chelo (Mugil), 328, 333, 334, 340.
Chelon, 331, 334.
chilensis (Brama), 77.
chilensis (Sarda), 102, 104.
Chiridæ, 147, 211.
Chirolophis, 213, 217.
Chironectes, 145.
Chondropterygians, 1.
Chondrosteans, 1.
Chorinemus, 82.
Chorisochismus, 300.
Christmas-fish. 406.
Chrysophrys, 56.
chrysops (Roccus), 44, 46.
cicatricosus (Pleuronectes), 404, 422, 429.
Ciliata, 544.
cimbrius, (cimbricus, Enchelyopus, Gadus, Motella, Onos), 544.
Cirrostomes, 1.
cithara (Callionymus), 279.
Citharichthys, 426.
Citharus, 371, 426.
claviger (Cottus), 188, 192.
Climbing-fish, 240.
Clinus, 219.
Clupea harengus, 149.
Clypeocottus, 187.
Coalfish, 465, 499, 500.
cobites (Aphya), 262, 265.
Cod, 465.
Cod, Bearded, 493.
Cod, Broad, 493.
Cod, Common, 472.
Cod, Green, 500.
Cod, Polar, 463, 484.
Cod, Poor or Power, 495, 498.
Cod, Tang, 477.
Cod, Three Bearded, 550.
coerulea (Pelamis), 93.
coeruleus (Cyclopterus), 294.
coeruleus (Labrus), 10.
Colfisch, 500.
colias (Scomber), 90, 110.
Colin, 500.
comber (Labrus), 7.
Commersonii (Scomber), 93.
communis (Lota), 532.
communis (Merlangus), 511.
compressus (Gadus), 532.
Concadita, 331.
Conger vulgaris, 143.
Connor, 18.
conspersus (Pleuronectes), 429, 430.
conspicillum (Batrachus), 135.
Corax, 200.
corax (Trigla), 201.
coretta (Thynnus), 91, 98.
Coris, 21.
cornubiensis (Labrus), 7, 18.
cornubiensis (Barbus minor), 558.
coronatus (Cyclopterus), 294.
corrugatus (Mugil), 334.
Corvina, 51.
Coryphæna, 96, 309.
Coryphænidæ, 70.
Cossyphus, 5.
Cottidæ, 126, 156.
Cottinæ, 156.
Cottomorphi, 126, 146.
Cotto-scombriformes, 70.
Cottunculus, 157.
Cottunculus, Small-eyed, 158.
Cottus, 146, 157, 168, 272, 273.
Cottus, Bearded, 208.
Cottus, Branch-spined, 160.
Cottus, Four-horned, 175.
Cottus, Short-spined, 180.
Couchia, 544.
Couchii (Acantholabrus), 5.
Couchii (Crenilabrus), 18.
Crenilabrus, 4, 8.
cristatus (Pleuronectes), 441.
cruentatus (Gobius), 248.
Crystallogobius. 242, 268.
Ctenodon, 224.
Ctenolabrus, 4, 16.
cuculus (Trigla), 195, 197.
Cuvieri (Trachurus), 88.
curtus (Mugil), 334.
Cybium, 89, 91, 99.
Cyclogaster, 282, 283.
Cyclopteridæ, 126, 147, 282.
Cyclopterus, 282, 293.
Cyclostomes, 1.
Cynicoglossus, 386.
Cynoglossus, 371.
cynoglossus (Glyptocephalus, Platessa, Pleuronectes), 364, 378, 383, 417.
Cyprinidæ, 66.
Cyprinodontidæ, 342.
Cypselurus, 356.
Cypsilurus, 356.
Cyttidæ, 304, 305.
Cyttomorphi, 126, 304.
Dab, Common, 386.
Dab, Lemon, 383.

Dab, Rough, 421.
Dab, Smear, 383.
dactyloptera (Scorpæna, Sebastes), 153, 522.
Dactylopterus, 146, 193.
Dajaus, 328.
Dealfish, 315.
decadactylus (Beryx), 67, 429.
decagonus (Agonus, Archagonus, Aspidophorus, Cottus, Podothecus), 204, 205, 206.
dentatus (Paralichthys, Pseudorhombus), 366.
dentex (Chorisochismus), 300.
denticulatus (Anarrhichas), 237.
Desfontainii (Lepadogaster, Mirbelia), 303.
diaphanus (Pleuronectes), 428.
diceraus (Ceratocottus), 187.
didactylus (Batrachus), 134.
Diplodus, 53.
dipterygia (Molua), 521, 525, 531.
Discoboles, 282.
Discoboli, 282.
dispar (Labrus), 10.
Dogge, 476.
Donovani (Crenilabrus), 18.
Donovani (Labrus), 7.
Doras, 188.
Dory, 306.
draco (Trachinus), 128, 272.
draculus (Callionymus), 273. 279.
Dracunculus, 272, 279.
dracunculus (Callionymus, Uranoscopus), 273.
Dragonet, Gemmeous, 273.
Dragonet, Lesser, 279.
Dragskädda, 391.
Drepanopsetta, 408, 420.
dubius (Mullus), 63.
Dvergsimpa, 191.
Dvergulk, 190.
dvinensis (Platessa) 405, 406.
dypterigius (Gadus), 521.
Echeneis, 89, 91.
Edwardii (Couchia), 545.
Eggerti (Anarrhichas), 236.
Ekströmii (Gobius), 262.
Ekströmii (Liparis), 284, 286.
Elacate, 89, 91.
Elbbutt, 443.
Eleginus, 482.
Eleotriformes, 240.
elongata (Glyptocephalus, Platessa, Pleuronectes), 379.
elongata (Lotta), 521.
Eleuterognathi, 2.
Encheliophis, 462.
Enchelyopus, 211, 537.
Engelsman, 425.
Enophrys, 181, 187.
Epinephelus, 48.
equirostrum (Scombresox), 353.
erythrinus (Sparus), 56, 57, 58.
esculentus (Merlucius), 515.
Esmarkii (Gadus), 466, 467, 499, 508.
Esox, 342.
Esox brasiliensis, 345.
Euchalarodus, 405.
europæus (Aspidophorus), 208.
europæus (Hemiramphus), 345.
eurybrachii, Acanthopterygii, 24.
euryripidi, Acanthopterygii, 24.
eurypterus (Lophius), 139, 142, 143.
Euthynnus, 91, 92.
euxinus (Gadus), 464, 487.
evolans (Exocœtus, Halocypselus), 358.
exiliens (Exocœtus), 358.
Exocœtiformes, 343.
Exocœtinæ, 355.
Exocœtini, 342.
Exocœtus, 356.
exoletus (Acantholabrus, Centrolabrus, Labrus), 4, 10, 14.
exoletus (Crenilabrus), 5.
exsiliens (Exocœtus), 358.
faber (Zeus), 305, 306.
Fabricii (Boreogadus, Gadus), 464, 484.
Fabricii (Liparis, Cyclogaster), 287, 288.
Fabricii (Lumpenus), 224, 225, 226.
Faisan d'eau, 440.
Father-lasher, 187.
Fenknoten, 200.
ferrugineus (Limanda, Pleuronectes), 390.
festiva (Julis), 21.
Fierasfer, 462.
Fishing-frog, 138.
Fjällflundra, 391.
Fjärsing, 128, 131.
Fjäsing, 131.
Flatfishes, 361.
flavescens (Bodianus, Perca), 27.
flavescens (Brosmius), 562.
flavescens (Gobius), 243, 244, 250, 251, 257.
Flek-Steenbit, 236.
flesus (Platessa, Pleuronectes), 378, 398, 407.
Flounder, 398.
Flounder, King's, 396.
Fluke, Sail, 451.
Flundra, 2, 403.
fluviatilis (Perca), 26.
Flydra, 416.
Flygfisk, 272.
Flying-fish, 355.
Flying-fish, Great, 357.
Fläckpagell, 59.
Forked-beard, Great, 540.
Forked-beard, Lesser, 558.
Franklinii (Pleuronectes), 404, 405.
Friesii (Gobius), 244, 248.
fuliginosus (Gadus), 559.
furcatus (Phycis, Physcis), 540.
furciger (Icelus), 166.
fuscus (Motella, Onos), 551, 556.
fuscus (Blennius, Raniceps), 558, 559.
Gadidæ, 462, 463.
Gadinæ, 464.
gadoides (Blennius), 540.
Gadus, 464, 514.
galeatus (Gymnacanthus), 160.
galerita (Blenniops, Blennius, Chirolophis), 218.
Gallichthys, 309.
Ganoids, 1.
Garpike, 347.
Gasterosteidæ, 341.
Gasterosteus pungitius, 264.
Gayi (Merlucius), 515.
gelatinosus (Careproctus, Cyclopterus, Liparis), 283, 287, 291.
germo (Orcynus, Thynnus), 90, 91, 97.
Gers, 41.
gibba, var. (Perca), 29.
gibbus (Labrus), 18.
gibbus (Liparis), 287.
Giersii (Pleuronectes), 395.
Gilt-head, 18.
Giofredi (Julis), 21.
glabra (Platessa), 405.
glacialis (Cottus), 180.
glacialis (Gadus), 484.
glacialis (Pleuronectes), 404, 405, 422, 429.
Glade, 391.
gladius (Cepola, Gymnetrus, Regalecus), 321, 323.
gladius (Xiphias), 118.
Glansfisk, 123.
Glashvarf, 448.
glauca (Ciliata, Couchia, Motella), 554, 556.
glauca (Lichia), 83.
glesne (Gymnetrus, Ophidium, Regalecus), 322.
Glib, 425.
Glibskädda, 425.
Glyptocephalus, 378, 379.
Glysa, 497.
Glyskolja, 495, 497.
Gmelini (Phycis), 543.
Gobiesocidæ, 126, 300.
Gobiesociformes, 239.
Gobiiformes, 239, 240
Gobiidæ, 126, 240.
Gobiinæ, 240.
gobio (Cottus), 157, 160, 169, 170, 173.
Gobioidei, 239.
Gobiomorphi, 126, 239.
Gobius, 157, 242.
gobius (Cyclopterus, Liparis), 284.
Goby, Black, 245.
Goby, Doubly spotted, 251.
Goby, Freckled, 262.
Goby, Jeffrey's, 261.
Goby, Spotted, 262.
Goby, White, 266.
Goldsinny, 16.
gracilis (Blennius, Clinus, Leptoblennius, Lumpenus), 225.
gracilis (Gadus, Tilesia), 465, 467, 481.
gracilis (Gobius), 248, 262.
gracilis (Perca), 27.
Grammiconotus, 352.
Grande Calimande, 451.
granulata (Perca), 27.
Grentaggiga Ulken, 160.
grisea (Lucioperca), 37.
griseus (Cantharus), 54.
Grillii (Gymnetrus), 322.
Grodqvabba, 144.
grœnlandicus (Cottus), 180.
grœnlandicus (Hippoglossus), 417.
Gråsej, 500, 503.
Gråsik, 503.
Grässnultra, 14.
Grästorsk, 476.
Guldmulle, 63.
Gudlax, 126.
Gunnel Spotted, 220.
gunnellus (Blennius, Centronotus, Murænoides, Ophisomus, Pholis), 220.
Gurnard, Grey, 197.
Gurnard, Red, 195.
Gurnard, Sapphirine, 200.
Gurnards, Cuirassed, 202.
gurnardus (Trigla), 194, 197.
guttatus (Lampris, Zeus), 123.
Gymnetrus, 320.
Gymnocanthus, 157, 159.
Gymnogaster, 314.
Gös, 36.
Haa-ising, 425.
Hæmulon, 52.
Haberdine, 479.
Haddock, 466.
Haddock, Norway, 148.
Hafgös, 50.
Hafgösfiskar, 49.
Hafkarp, 10.
Hafkatt, blå, 237.
Hafkatt, tigerfläckad, 236.
Hafkatt, vanlig, 232.
Hafpadda, 561.
Hafsabborre, 45.
Hafspadda, 144.
Hafsruda, 52.
Hafulk, 144.
Hake, 465, 515.
Hake, Trifurcated, 559.
Halfulk, 163.
Halhös, 197.

Halibut, 409.
Halibut, Lesser, 417.
Halocypselus, 356.
Haloporphyrus, 539.
hamatus (Centridermichthys, Icelus), 165.
Hansing, 396.
Haploidonotus, 49.
Havkvabbe, 543.
Havmuus, 211.
Hawkenii (Gymnetrus), 322.
Hawkinsii (Gymnetrus), 322.
Heiligbutt, 416.
Heilag-fiske, 416.
helvetica (Perca), 27.
Helgeflundra, 409, 416.
Helgeflundran, lilla, 417.
Helleflyndre, 416.
Hemibranchii, 2.
Hemilepidotus, 156.
Hemirhamphiformes, 343.
Hemirhamphus, 342.
Hemirhombus, 426.
heptagonus (Cyclopterus), 294.
Herrings, King of the, 322.
Heterocormi, 24.
Heterolepidotidæ, 147, 211.
Heterosomata, 361.
Heterosomes, 361.
hexacornis (Cottus), 175, 178.
hiatula (Labrus), 11.
Hierax, 352.
Hippoglossina, 371, 408.
Hippoglossoides, 420.
hippoglossoides (Hippoglossus, Platysomatichthys, Pleuronectes, Reinhardtius), 408, 417.
Hippoglossus, 408, 409, 420.
hippoglossus (Pleuronectes), 409.
Hirax, 352.
hirtus (Pleuronectes, Rhombus, Zeugopterus), 458.
Hirundo, 200, 356.
hirundo (Trigla), 195, 197, 200.
Histiophorus, 117.
histrio (Antennarius, Lophius), 136, 145.
Hlyre, 236.
Holocentrini, 66.
Holocentrum, 66, 69.
hololepidotus (Labrus, Sciæna), 52.
Hork, 43.
Hornfisk, 347.
Horngädda, 347.
Horngäll, 347.
Hornsimpa, 175.
Hornskalle, 184, 185.
Horntunga, 425.
Hornuggla, 211.
Hornulke, 190.
Horr, 43.
Horse-Mackerel, 86.
Horunge, 393, 443.
huntia (Molva), 532.
Hulekolja, 561.
hurta (Sparus), 56.
Hvarf, luden, 456.
Hvitling, 487.
Hvitlinglyra, 508.
hybridus (Rhombus), 432.
Hällefisk, 416.
Hälleflundra, 416.
Icelus, 162.
idiopteri, Acanthopterygii, 24.
imberbe (Ophidium), 220.
imbricatus (Acantholabrus), 5.
imperiale (Ramphistoma), 349.
imperialis (Sebastes), 154.
inornata (Lota), 532.
interruptus (Roccus), 44.
iris (Trachypterus), 310, 311, 312, 313.
Isa, 466.
Ising, 391.
islandicus (Bogmarus, Vogmarus), 315.
islandicus (Centronotus, Gunellus, Lumpenus, Stichæus), 225.
italica (Perca), 27.
jacksoniensis (Regalecus, Trachypterus), 314.
japonica (Brama), 77.
japonicus (Zeus), 306, 308.
Jeffreysii (Gobius), 244, 261.
John Dory, 306.
jozo (Gobius), 245, 246.
Judepiga, 425.
jugulares, Acanthopterygii, 24.
Julidinæ, 20.
julis (Coris, Labrus), 21.
Jydekjærling, 425.
Jydetunga, 378.
Jydetunge, 425.
Kabeljaauw, 476.
Kabiljo, 473, 476.
Kalleraglik, 418.
kanagurta (Scomber), 90, 110.
Kaulbarsch, 43.
Keila, 562.
King of the Herrings, 322.
kitt (Pleuronectes), 383.
Klarstubb, 266.
Knerii (Polyprion), 48.
Knorrhane, 197.
Knot, 197.
Kolja, 466.
Kolje, 497.
Kolmule, 511.
Kolmulehvitling, 511.
Kolmun, 511.
Kordylos, 99.
Kuderusk, 211.
Kullbas, 43.
Kullribas, 43.
Kulmund, 519.
Kummel, 515, 519.
Kumrill, 540, 543.
Kungsfisk, 148, 152.
Kungsflundra, 396.
Kveise, 131.
Käring, 151.
Laberdan, 479.
labradoricus (Cottus), 180.
Labrax, 45.
labrax (Perca, Roccus), 45.
Labridæ, 3.
Labrina, 4.
Labroid, 3.
Labroides, 2.
Labromorphi, 2.
Labrus, 2, 5.
lacustris (Gadus, Lota), 532.
Læmonema, 539.
lævigatus (Chironectes), 145, 146.
lævis (Arnoglossus), 428.
lævis (Cataphractus, Pholis), 214.
lævis (Pleuronectes), 383.
lævis (Pleuronectes, Rhombus), 441.
lævis (Trigla), 201.
Lakatrubb, 174.
Lake, 532.
Lakegers, 174.
lampretiformis (Blennius, Clinus, Lumpenus), 225.
Lamprididæ, 70, 121.
Lamprini, 121.
Lampris, 122, 309.
lanceolatus (Gobius), 24.
Lancelet, 1.
Lantern-fish, 428.
laterna (Arnoglossus, Platophrys, Pleuronectes) 426, 428, 429.
laticeps (Gobius), 258.
latidens (Microstomus), 383.
latifrons (Anarrhichas), 232, 237.
lauta (Lampris), 124.
Laxestörje, 125.
leachianus (Scomber), 93.
Lebetus, 259.
leopardus (Anarrhichas), 236.
Leotardi (Pleuronectes), 428.
Lepadogaster, 301.
Lepibema, 44.
Lepidopleurini, 71.
Lepidorhombus, 426, 447.
Leptagonus, 206.
Leptoblennius, 224.
leptocephalus (Gadus), 500.
Leptoclinus, 224.
Lepturus, 314.
lepturus (Caranx), 85.
Lerbleking, 504, 506.
Lerflundra, 421.
Lerstubb, 256.
Lesueurii (Gobius), 248, 249, 250.
Leuciscus rutilus, 186.
Lichia, 82, 85.
Lilljeborgii (Cottus), 169, 191.
Limanda, 386.
limanda (Hippoglossoides, Hippoglossus), 421.
limanda (Pleuronectes), 378, 386, 407.
Limandelle, 451.
limandoides (Hippoglossoides, Platessa, Pleuronectes), 421, 429.
linearis (Gobius), 269.
lineata (Achirus, Solea), 364.
lineata (Liparis), 287.
lineatus (Beryx), 68.
lineatus (Cantharus, Sparus), 54.
lineatus (Cyclopterus, Liparis), 284.
lineatus (Exocœtus), 358.
lineatus (Labrus), 7, 10.
lineatus (Lepadogaster), 303.
lineatus (Roccus), 44, 45, 46.
Ling, 230, 526.
linguatula (Citharus), 371.
linguatula (Pleuronectes), 421.
Linnei (Æglefinus), 466.
Linnei (Cantharus), 54.
Linnei (Hippoglossus), 410.
Linnei (Labrax), 45.
Linnei (Lota), 532.
Linnei (Merlangus), 487.
Linnei (Merluccius), 516.
Linnei (Molva), 526.
Linnei (Pollachius), 504.
Linnei (Solea), 373.
Linnei (Thynnus), 98.
Linnei (Trachurus), 86.
lioderma (Pleuronectes), 441.
Liparis, 157, 283.
liparis (Cyclogaster, Cyclopterus), 284, 287.
liparoides (Cyclopterus, Liparis), 284.
Lip-fish, 3.
Liza, 331.
Loligo sagittata, 120.
longipinnis (Brama), 76, 80, 429.
longus (Asellus), 526.
Lophiidæ, 126, 136.
Lophius, 138.
Lophobranchii, 2.
Lophonectes, 426.
Lophotes, 309, 320.
Lophotidæ, 309.
Lophotiformes, 309.
lota (Gadus, Lota, Lotta), 531, 532.
Lotella, 521.

Lotinæ, 464.
Lotta, 464, 520, 530.
Lubb, 519, 565.
lubb (Gadus), 562.
Lucerna, 200, 202.
lucerna (Trigla), 194, 199, 200.
Lucifuga, 462.
Lucioperca, 36.
lucioperca (Perca, Stizostedium), 36.
Luden Hvarf, 456.
Lumpenus, 213, 224.
lumpenus (Blennius, Centronotus), 225.
Lumpenus, Blunt-tailed, 225.
Lumpenus, Sharp-tailed, 228.
Lumpfisk, 283.
Lump-Sucker, 294.
lumpus (Cyclopterus), 294.
luna (Chrysotosus, Lampris, Zeus), 123.
lunatus (Platophrys), 430.
lupus (Anarrhichas), 232, 237.
lupus (Centropomus, Labrax), 45.
Lupus marinus, 234.
luscus (Labrus), 5.
luscus (Gadulus, Gadus), 466, 467, 493, 495.
luscus (Platessa, Pleuronectes), 399.
Lycodidæ, 211, 463.
lycostomus (Gadus), 504.
Lyr, 506.
lyra (Callionymus, Uranoscopus), 272, 279.
lyra (Trigla), 195.
Lyrbleck, 506.
Lyrtorsk, 504, 506.
Lysi, 519.
Lysing, 515, 516, 518.
Lysipharyngii, 2, 23.
lysan (Chorinemus), 83.
Långa, 526.
Långebarn, 230, 530.
Långebarn, spetsstjertadt, 225.
Långebarn, trubbstjertadt, 228.
Mackerel, 110.
Mackerel, Frigate, 108.
Mackerel, Horse, 86.
Mackerel, Spanish, 1.
Mackerel-guide, 351.
macrocephalus (Gadus), 464, 473, 474, 475.
macrolepidotus (Pleuronectes), 370.
macrophthalma (Phycis, Molua), 521.
macrophthalmus (Gobiesox), 300.
macrophthalmus (Onos), 544.
macropterus (Thynnus), 91.
Macruridæ, 461, 463, 539.
maculata (Motella, Onos), 550, 551.
maculata, var. (Perca), 29.
maculatus (Bothus, Rhombus), 366, 432.
maculatus (Callionymus), 272, 279.
maculatus (Clinus, Ctenodon, Leptoclinus, Lumpenus, Stichæus), 228.
maculatus (Labrus), 7.
maculatus (Lepadogaster), 303.
maculatus (Liparis), 284, 286.
maculosa (Gadus, Lota, Molva), 532.
maculosa (Perca), 18.
mæoticus (Bothus), 437.
Maigre, 50.
major (Barbus), 540.
major (Liparis) 287.
major (Molva), 526.
major (Perca), 26.
Makrilgädda, 353.
Makrilstörje, 97, 125.
Malacanthidæ, 127.
Malacopterygii, 341.
malabarica (Scorpæna), 154.
malarmoides (Aspidophorus), 206.
Mancopsetta, 426.
Mareflundra, 385.
Mareflynder, 425.
Mareskädda, 398.
Marieskädda, 398.
marina (Perca), 149.
marinus (Sebastes), 148.
marmorata, var. (Pleuronectes), 402.
marmoratus (Antennarius, Chironectes), 146.
Marulk, 138.
Mastacembelidæ, 211.
Mastacembeliformes, 343.
Mastacembelus, 344.
Matfar, 558, 561.
maximus (Bothus, Pleuronectes, Rhombus), 427, 433, 434, 442.
maximus (Hippoglossus), 410.
maximus hybridus (Bothus), 433, 444.
mediterranea (Julis), 21.
mediterraneus (Gadus, Onos), 551, 556.
mediterraneus (Phycis), 539.
mediterraneus (Scomber), 105.
mediterraneus (Thynnus), 98.
mediterraneus (Trachurus), 88.
medius (Lumpenus), 224, 225.
megastoma (Arnoglossus, Lepidorhombus, Pleuronectes, Rhombus, Zeugopterus), 447, 448.
Megrim, 428.
Melandrys, 99.
melanogaster (Pseudorhombus), 366.
Melanogrammus, 467.
melanostomus (Gadus), 511.
melanura (Julis), 21.
melops (Crenilabrus, Labrus), 4, 18.
membranaceus (Paraliparis), 283.
Menidæ, 52.
mento (Exocœtus), 355.
Menuaggia, 432.
meridionalis (Aphia), 266.
Merlangus, 487.
merlangus (Gadus), 464, 466, 467, 487, 511.
Merlu barbu, 540.
merluccius (Merlucius), 515.
Merluciinæ, 464.
Merlucius, 464, 514, 515.
Merlus 515.
Merluzzo, 518.
Merulk, 138.
microcephalus (Platessa, Pleuronectes), 378, 383.
microps (Cottunculus), 158.
microps (Gobius), 244, 255, 256, 257, 258.
micropus (Liparis), 292.
microstoma (Crenilabrus), 15.
microstomus (Pleuronectes), 383.
milvus (Trigla), 197.
minimus (Gadus), 559.
minor (Anarrhichas), 232, 236.
minor (Couchia), 554.
minor (Perca), 41.
minuta (Aphya, Atherina), 265, 266, 432.
minutus (Cyclopterus), 294.
minutus (Gadulus, Gadus), 466, 493, 508.
minutus (Gobius), 243, 244, 251, 255, 257, 258, 262, 294, 425.
Mirbelia, 301, 303.
Mirbelii (Lepadogaster), 303.
mixtus (Labrus), 4, 6, 10.
Mogki (Rhomboidichthys), 427.
Molua, 464, 520.
Molva, 520.
molva (Gadus, Lota, Molua, Molva), 521, 525, 526, 528, 531.
Monflundra, 385.
Montagui (Cyclopterus, Liparis), 284.
morhua (Gadus), 472.
mormyrus (Sparus), 56, 57.
Morone, 44.
Morrhua, 520.
morrhua (Gadus), 472.
Mort, 503.
Morue, 520.
Motella, 543.
Motellinæ, 464.
mucosus (Cyclogaster, Neoliparis), 286, 293.
Mudderskrubbe, 403.
Mugil, 328, 330, 342.
Mugilidæ, 126, 327, 328.
Mugiliformes, 126, 327.
Mullet, Golden, 337.
Mullet, Red, 63.
Mullet, Thicklipped grey, 334.
Mullet, Thinlipped grey, 339.
Mullidæ, 25, 61.
Mulloides, 61.
Mullus, 62.
multidentatus (Labrus, Crenilabrus), 7, 8.
Mulus, 62.
Murænolepis, 461.
mustela (Gadus, Motella, Onos), 544, 545, 554.
mustelaris (Blennius), 219.
mustelaris (Gadus), 554.
mustella (Gadus, Onos), 550, 551.
Myxine glutinosa, 472.
Myxus, 328.
Nasello, 518.
Naucrates, 82, 83.
navaga (Gadus), 465, 467, 481, 514.
Neoliparis, 286.
nesogallicus (Chironectes), 146.
Nestis, 328.
Neustriæ (Labrus), 7.
niger (Gobius), 241, 244, 245, 255, 343, 461.
niger (Raniceps), 559.
nigripes (Trigla), 197, 201.
nigromanus (Pleuronectes), 379.
Nilsonii (Crystallogobius, Gobiosoma, Gobius, Latrunculodes, Latrunculus), 269.
Nonnat, 264, 432.
norvegicus (Crenilabrus, Labrus, Lutjanus), 18.
norvegicus (Holocentrus, Perca, Sebastes), 148.
norvegicus (Lepidorhombus, Rhombus, Scophthalmus, Zeugopterus), 427, 452, 453.
Norway Haddock, 148.
nostras (Liparis), 287.
Nounat, 264.
Novaga, 481.
nuda (Orcynopsis, Pelamys), 103, 104.
nudus (Cyclopterus, Gobiesox), 300.
Nålle, 503.
Näbbgädda, 347.
Oceanica (Limanda), 387.
ocellaris (Blennius), 212, 219.
ocellatus (Lepadogaster), 303.
ogac (Gadus), 464, 465, 467, 479.
ogat, 480.
Ombrina, 50.
onitis (Labrus, Tautoga), 11.
Onomorphi, 461.
Onos 464, 515, 518, 543.
Opah, 123.
Ophidiidæ, 461, 463.
Ophiocephalidæ, 328.
Ophiuræ, 425.
Opistomi, 211.
orbicularis (Cantharus), 54.
orca (Gobius), 244, 259, 260.
Orcynopsis, 91, 102.
Orcynus, 91, 92, 96, 99.
Oreosoma, 305.
Oreosomatidæ, 305.
orientalis (Thynnus), 91, 98, 101.
Orthagoriscus, 1, 2.
Orthocormi, 24.
ossifagus (Labrus), 10.
Otolithus, 51.
ouak, 479.

ovak, 479.
ovis (Sargus), 53.
Oxsimpa, 187.
oxygeneios (Epinephelus), 48.
Ozzone, 331.
pacifici (Batrachus), 133, 135.
pacificus (Cynicoglossus), 386.
pacificus (Thynnus), 91.
Paddtorsk, 558.
Paddulk, 158.
Paddål, 561.
Pagellus, 56.
Pagrus, 56.
Pagurus, 425.
Pale, 503.
Pallasii (Pleuronectes), 392, 395.
Pallonii (Labrus), 4, 5.
palmicornis (Blennius, Chirolophis), 218.
pantherinus (Anarrhichas), 236.
Paralichthys, 366, 408, 420.
Paraliparis, 283.
Parexocœtus, 356.
Parnelli (Gobius), 261.
Parophrys, 377.
paroticus (Labrus), 21.
passer (Flesus, Platessa, Pleuronectes), 398, 399, 441.
Passer fluviatilis, 402.
patris (Acanthocottus) 160.
pavonina (Pleuronectes), 441.
pavoninus (Cyclopterus), 294.
Pediculati, 136.
pediculati, Acanthoptherygii, 24.
pediculati, Anomali, 24.
pelagicus (Lampris, Scomber), 123.
Pelamis, 99.
Pelamis, Plain, 103.
Pelamis, Striped-backed, 105.
pelamis (Euthynnus, Scomber), 91, 95.
pelamis (Orcynus, Sarda), 92, 105.
Pelamys, 104.
pelamys (Euthynnus, Thynnus), 95.
pelamys (Sarda), 105.
pellucidus (Aphia, Aphya, Gobius, Latrunculus), 266.
pellucidus (Thyris), 363.
Pennantii (Crenilabrus), 18.
Perca, 25, 26.
Percesoces, 328.
Perch, 26, 44.
Perch, Carass, 29.
Perch, Deep-water, 30.
Perch, Leaf, 30.
Perch, Mud, 30.
Perch, Pike-, 36.
Perch, Sea-, 45.
Perch, Sedge, 30.
Perch, Spotted, 29.
Perch, Stone, 30.
Perches, Sea-Pike, 49.
Percidæ, 25.
Percinæ, 25.
Percis, 127.
Percomorphi, 25.
peregrinus (Thynnus), 103.
Periophthalmus, 240.
Peristedion, 193.
Permuck, 554, 557.
Pharyngognathi, 2.
Pharyngognathi malacopterygii, 342.
Phobetor, 159.
Pholis, 213, 220.
pholis (Blennius), 214.
Phoxinus aphya, 33.
Phrynorhombus, 452.
Phycinæ, 464.
Phycis, 464, 531, 538.
phycis (Blennius), 539.
Physiculus, 539.
Physoclysts, 1.
pictus (Chironectes), 146.
pictus (Gobius), 241, 244, 255, 257, 258.
pictus (Uranoscopus), 272, 273.
Pifvare, 441.
Piggmakrel, 87.
Pigghvarf, 434, 441.
Pigghvarfvel, 441.
Piggvarr 441.
Pike, Saury, 353.
Pilote-fish, 83.
Pingelii (Triglops), 167.
Pinguipes, 127.
pinguis (Hippoglossus, Platysomatichthys, Pleuronectes), 417.
pini (Trigla), 194, 195.
piscatorius (Lophius), 136, 138.
piscatrix (Lophius, Rana), 138, 139.
pistilliger (Cottus, Gymnocanthus, Phobetor), 160, 161.
Plagusia, 363.
Plaice, 392.
planifrons (Batrachus), 135.
Plank, 506.
Platessa, 392.
platessa (Pleuronectes), 365, 378, 392, 401, 407.
platessoides (Citharus, Drepanopsetta, Hippoglossoides, Pleuronectes), 376, 387, 408, 421, 429, 454.
Platophrys, 364, 426, 427.
platycephalus (Cottus), 181, 182.
Platysomatichthys, 408, 416.
Plectognathi, 1, 344.
Pleuronectes, 377, 378.
Pleuronectidæ, 366, 377.
Pleuronectina, 371, 377.
Pleuronectini, 370.
pleurostictus (Triglops), 167.
Pluddermun, 385.
pneumatophorus (Scomber), 110.
podas (Rhomboidichthys), 366.
Podothecus, 206.
pœciloptera (Trigla), 195, 201.
pœcilopus (Cottus), 169, 173.
Pogonias, 49.
pola (Platessa, Pleuronectes), 379, 383.
polaris (Boreogadus, Gadus), 484.
Pole, 378.
Pollachius, 504.
pollachius (Gadus, Merlangus), 466, 467, 504.
Pollack, 499, 504.
Pollack, Norwegian Whiting-, 508.
Polycentrus, 11.
Polyprion, 25, 47.
Polypterus, 343.
Pomatomus, 82.
Pope, 41, 44.
Porcellus, 41.
Porichthys, 133.
porosus (Cottus), 180.
Potta, 441.
Poutassou, 511.
poutassou (Boreogadus, Gadus, Merlangus), 465, 466, 467, 511.
Præsteflyndre, 396.
princeps (Brama), 80.
probatocephalus (Diplodus), 53.
productus (Gadus, Merlucius), 464, 516.
proximus (Gadus), 467, 490.
Psammodiscus, 377.
Psettichthys, 408.
Psettodes, 408.
pseudoflesus (Platessa), 393, 403.
pseudogastropteri, Orthocormi, 24.
Pseudorhombus, 366, 408, 420.
Pteraclis, 70, 71.
Pterophryne, 145.
Pterycombus, 70, 71, 72.
pulcher (Scomber), 95.
punctata (Labrus, Sciæna), 11.
punctatus (Batrachus), 135.
punctatus (Lepadogaster), 303.
punctatus (Pleuronectes, Rhombus, Zeugopterus), 383, 427, 456.
punctatus, var. (Scomber), 111.
punctulatus (Batrachus), 135.
pungio (Zeus), 308.
purpureus (Gadus, Merlangus), 500.
pusillus (Labrus), 7.
Putnami (Euchalarodus), 405.
Pycnodonta, 71.
Pycnodontoidei, 71.
quadricornis (Cottus), 169, 175.
quadricornis (Motella), 550, 553.
quadridens (Pleuronectes), 383.
quadrimaculatus (Gobius), 261.
quadripunctatus (Scomber), 93.
quadrituberculatus (Pleuronectes), 392, 395.
quadrivittatus (Gobius), 263.
Quenselii (Pleuronectes), 383.
Querimana, 328.
Qvabbso, 297.
Qveite, 416.
quinquecirrhatus (Gadus, Motella), 554.
Radfläckiga Tungehvarfven, 428.
radiatus (Trachinus), 128.
Raji (Brama, Sparus), 76, 77, 80, 429.
Raniceps, 464, 558.
raninus (Blennius, Gadus, Raniceps), 558, 559.
ranula (Liparis), 287.
raptor (Gadus, Molua), 526, 527.
Raschii (Brama), 80.
Rav, 415.
Regalecus, 320.
regulus (Sebastes), 150.
Reinhardi (Careproctus, Liparis), 292.
remipes (Gymnetrus, Regalecus), 322.
repandus (Trachypterus), 312.
reticulatus (Callionymus), 279.
reticulatus (Lepadogaster), 303.
reticulatus (Liparis), 286.
Rhamphistoma, 344.
Rhinomugil, 328, 333.
rhomboides (Rhombus), 452.
Rhomboidichthys, 364, 427.
Rhombus, 432.
rhombus (Bothus, Pleuronectes), 427, 433, 441.
rhombus hybridus (Bothus), 433, 445.
Rhynchichthys, 24.
riali (Onus), 515.
Ringbug, 283.
Ringbuyk, 283.
robustus (Clypeocottus), 187.
Roccus, 25, 44.
rocheanus (Thynnus), 108.
Rochei (Auxis, Scomber), 108.
Rock-cook, 14.
Rockling, Five-Bearded, 554.
Rockling, Four-Bearded, 544.
Rockling, Northern, 548.
Rockling, Three-Bearded, 550.
Rogn-kal, 297.
Rogn-kexe, 297.
Rondeletii (Exocœtus), 358.
Rondeletii (Scombresox), 353.
rone (Labrus), 18.
roseus (Pleuronectes), 401.
rostrata (Belone), 347.
Rotskär, 503.
ruber (Gadus). 473.
ruber (Urocentrus), 67.
Rudabborre, 29.

Ruff, 41.
rumulo (Bothus), 441.
rupestris (Crenilabrus, Ctenolabrus, Labrus, Perca, Sciæna), 4, 6, 16.
Ruska, 403.
Ruskeskädda, 403.
Russellii (Regalecus), 321.
Ruthensparri (Gobius), 251.
Rånka, 297.
Räkling, 415.
Röbug, 256.
Rödfisken, 152.
Rödknoten, 195.
Rödnäbba, 14.
Rödsnäcka, 14.
Rödspotta, 392, 398.
Rödspätta, 398.
Rödtorsk, 477.
Rötsimpa, 180.
Sabbik, 262.
saida (Boreogadus, Gadus), 463, 464, 465, 467, 484, 514.
Sail-Fluke, 451.
Salarias, 212.
Salilota, 531.
Salmon, Spanish, 507.
salmonea (Perca), 37.
Sandhvarf, 443.
Sandflundra, 385, 390.
Sandflundre, 403.
Sandflynder, 390.
sandra (Lucioperca), 36.
Sandskrubbe, 403.
Sandskädda, 390, 425.
Sandstubb, 262.
Sandtunga, 375.
Sanktepersfisk, 306.
Sarda, 91, 102, 104.
sarda (Orcynus, Pelamys, Scomber, Thynnus), 105.
Sargini, 53.
Saurus, 352, 353.
saurus (Esox, Scombresox), 353.
saurus (Trachurus), 86.
Saussurii (Brama), 81.
saxicola (Glyptocephalus, Platessa, Pleuronectes), 379.
Sagris, 352.
scaber (Chironectes), 146.
Scad, 86.
Scarabæus, 54.
Scarus, 2, 4.
Scharretong, 378.
Schomburgkii (Polycentrus), 11.
Schilus, 36.
Scholle, 398.
Sciæna, 50.
Sciænidæ, 25, 49.
Scleroparei, 146.
Scomber, 110.
scomber (Scomber), 111.
Scomberesoces, 342.
Scomberesox, 352.
Scomberomorus, 89, 91, 105.
Scombresocidæ, 343.
Scombresociformes, 343.
Scombresox, 352.
Scombridæ, 70, 89.
Scombroidea, 121.
Scombromorphi, 69.
scombrus (Scomber), 83, 92, 110.
Scophthalmus, 452.
Scorpæna, 143, 146, 153.
scorpæna (Cottus), 180.
Scorpænidæ, 126, 147.
scorpioides (Gobius), 244, 260.
scorpius (Cottus), 157, 169, 180.
scriptus, var. (Scomber), 112.
scutellatum (Scombresox), 353.
Sea-Bream, Black, 54.
Sea-Bream, Common, 59.
Sea-Bream, Rasch's, 80.
Sea-Bream, Ray's, 77.
Sea-Bream, Spanish, 58.
Sea-Cat, Blue, 237.
Sea-Cat, Common, 232.
Sea-Cat, Spotted, 236.
Sea-Pheasant, 440.
Sea-Scorpion, 180.
Sea-Snail, 283.
Sea Pike-Perches, 49.
Sea-Snail, Common, 287.
Sea-Snail, Montagu's, 284.
Sea-Snail, Slimy, 291.
Sebastes, 146, 148.
Sebastodes, 147, 148.
secundo-dorsalis (Thynnus), 91, 98, 101.
Sej, 500, 503.
Sejlyra, 506.
Selene, 83, 85.
semispinosus (Caranx), 86.
septentrionalis (Motella, Onos), 544, 548, 557.
septentrionalis (Mugil), 334.
Serpula, 332.
Serranus, 3.
serrato-granulata (Perca), 27.
setipinnis (Selene), 83.
Shadow-fish, 50.
Shanny, 215.
sibi (Thynnus), 91.
Silfverfisk, 87.
Sillkung, 322.
Sillmör, 507.
Siluridæ, 66.
Simpa, 179.
sinuatus (Merlucius), 516.
Siphagonus, 203.
Sjurygg, 294, 297.
Sjöhane, 306.
Sjökock, 151, 272, 273.
Skaboskädda, 396.
Skattbonde, 41.
Skavskädda, 396.
Skipper, 353.
Skinnskrabba, 185.
Skjælbrosme, 543.
Skjær-ising, 382, 425.
Skotta, 18.
Skrabb, 185.
Skrej, 87, 476.
Skrobba, 398.
Skrubba, 403.
Skrubbskädda, 398, 403.
Skyggfisk, 214.
Skålla, 398.
Skålling, 29, 30.
Skädda, 377.
Skäggsimpa, 208.
Skäggtorsk, 493.
Skälryta, 185.
Skär-auer, 155.
Skärflundra, 378.
Skärlånga, 543.
Skärlånga, femtömmad, 554.
Skärlånga, fyrtömmad, 544.
Skärlånga, nordisk, 548.
Skärlånga, tretömmad, 550.
Skärsnultra, 18.
Släthvarf, 441, 443.
Släthvarfvel, 443.
Slätta, 391, 398.
Slätte, 391,
Slättika, 391.
Slätt-vahr, 392.
Slättvar, 443.
Smear Dab, 383.
Smed, 561.
smiridus (Merluccius), 515.
Småhvarf, 453.
Småsej, 503.
Småtorsk, 476.
Smörbult, svart, 245.
Snorfojbul, 297.
Snorgers, 41.
Snorluf, 41.
Snorpels, 41.
Sockerskädda, 382.
Sole, 372, 386.
Sole, Smooth, 428.
Solea, 371, 372.
solea (Pleuronectes), 372.
soleæformis (Arnoglossus, Rhombus), 429.
Soleina, 371.
Soleini, 370.
Soles, Double, 375.
Soles, Reversed, 375.
Spær, 511.
Sparidæ, 25, 52.
Sparini, 53.
Sparus, 56.
speciosa (Julis), 21.
speciosus (Labrus), 10.
spet (Sphyræna), 327.
Spetsstjertadt Långebarn, 225.
Sphyrænidæ, 327.
Spillånga, 530.
Spindelflynder, 379.
spinosus (Cyclopterus), 298.
spinosus (Zeus), 306.
spinosissimus (Aspidophorus, Leptagonus), 206.
splendens (Beryx), 68, 429.
Spätta, 398.
Squamipinnes, 49, 52, 71.
Staggsill, 87.
Stainbuck, 297.
Stainbäjtare, 297.
Staksill, 87.
Stamp, 530.
Steinbits-Broder, 236.
Steinbutt, 441.
stellatus (Liparis), 290.
stellatus (Platessa, Pleuronectes), 399, 403.
Stenbider, 235.
Stenbit, 297.
Stenbrosme, 543.
Stenflundra, 441.
Stengers, 174.
Stenlake, 172, 537.
stenobrachii, Acanthopterygii, 24.
stenoripidi, Acanthopterygii, 24.
Stensnultra, 16.
Stenspotta, 441.
Stensimpa, 170.
Stensugare, 172, 385.
Stensut, 172.
Sternoptychidæ, 305.
Sternoptyx, 305.
Stickleback, 2.
Stizostedium, 25, 36.
Stockfisk, 503.
Stone-Basse, 47.
Storgap, 425.
Storgneding, 200.
Stormun, 425.
Stortorsk, 476.
Strinsia, 463.
Strœmii (Carelophus, Gunnellus), 218.
Stuvitzii (Boreogobius, Gobiosoma, Gobius, Latrunculus), 266.
Stylophorus, 314.
Sucker Bimaculated, 302.

Sucker, Lump, 294.
Sudernal, 14.
Sugare, 283.
Sugfisk, 283.
Sujefianus (Blennius), 213.
suillus (Ctenolabrus, Labrus), 16.
Sula, 375.
superciliosus (Clinus), 219.
surmuletus (Mullus), 63.
Svart Smörbult, 245.
Svarttorsk, 477.
Svärdfisk, 222.
Swordfish, 118, 221.
Synentognathi, 342.
Syngnathus, 347.
Sypiga, 14.
Såla, 375, 425.
Sö-abborre, 10.
Sölvqveite, 314, 315.
Tacaud, 493.
Tadpolefish, 558.
Tænia, 314.
Tæniiformes, 309.
Tænioides, 309.
tæniopterus (Cottus), 181.
tænuis (Arnoglossus), 428.
Taggmakril, 86.
Taggsill, 87.
tancoides (Labrus), 7.
Tangbrosme, 223.
tapeinosoma (Arnoglossus), 428, 430, 431.
Tara, 482.
Taretorsk, 477.
tau (Batrachus, Gadus), 134.
tazo (Scomber), 108.
Tejstefisk, 222.
Teleostei, 1.
Temnodon, 82, 85.
Tephritis, 408.
tessellatus (Labrus), 11.
Teste, 222.
Testefisk, 220.
Tetragonuridæ, 327.
Tetragonurus, 327.
Tetrapturus, 117.
Thalassophryne, 133.
thazard (Auxis, Scomber), 89, 92, 108.
Tholichthys, 24.
Thomsonii (Cottus), 157.
thoracici, Acanthopterygii, 24.
thoracopteri, Orthocormi, 24.
thunina, thunnina (Euthynnus, Orcynopsis, Scomber, Thynnus), 93.
thynnus (Orcynus, Scomber, Thynnus), 91, 97, 101.
Thyris, 363.
Tilesia, 482.
tinca (Labrus), 7, 18.
tinca (Strinsia), 463.
Tigerfläckad hafkatt, 236.
Tistelfisk, 222.
Toadfish, Common, 135.
Toadfish, European, 134.
Topknot, Ekström's, 453.
Topknot, Müller's, 456.
Torsk, 472, 562.
torvus (Caranx), 85.
torvus (Cottunculus), 157.
Trachinidæ, 126, 127.
Trachinini, 127.
Trachinomorphi, 126, 127.
Trachinus, 128, 272.
Trachipterus, 314.
Trachurus, 84.
trachurus (Caranx, Scomber, Trachurus), 83, 84, 85, 86.
trachurus (Hemilepidotus), 156.
Trachydermus, 162.
Trachynotus, 82, 85.
Trachypteridæ, 126, 309.
Trachypteromorphi, 126, 309.
Trachypterus, 304, 310, 312, 314.
Trichiuridæ, 309.
Trichonotidæ, 211.
tricirratus (Gadus, Motella, Onos), 544, 550, 551, 556.
tricuspis (Cottus, Phobetor), 160.
tridactylus (Salarias), 212.
trifurcus (trifurcatus, Blennius, Raniceps), 559.
Trigla, 146, 194.
Triglinæ, 193.
Triglops, 157, 166.
trimaculatus (Labrus), 10.
Trubbstjertadt långebarn, 228.
Tubfish, 200.
Tryte, 28.
tumidus (Chironectes, Lophius), 145, 146.
Tumula, 331.
Tunfisk, 97.
Tunga, 372.
Tungehvarf, radfläckig, 428.
Tungens hoer-unge, 425.
Tunglik flundra, 391.
tunicatus (Liparis), 287.
Tunnina, 93.
Tunny, 90, 97.
Turbot, 368, 432, 434, 435.
turdus (Labrus), 18.
Tusk, 562.
typus (Carangichthys), 83.
Tångsnärta, 218.
Uakal, 481.
Uægte Tunge, 425.
Ulk, 185, 190.
umbra (Sciæna), 51.
uncinatus (Centridermichthys, Cottus, Icelus), 163.
unicolor (Orcynopsis, Pelamichthys, Pelamys, Scomber), 91, 103.
unicolor (Sparus), 53.
unimaculatus (Rhombus, Scophthalmus), 452.
unipunctatus (Gobius), 262.
Upenæus, 61.
Ur, 152.
Uraleptus, 539.
Uranidea, 157, 169, 170.
Uranoscopus, 272.
Uraspis, 83.
uraspis (Caranx), 83.
Urocentrus, 67.
Urokadlin, 481.
Uäkän, 481.
Vaagmaer, 315.
Vanlig Hafkatt, 232.
variabilis (Acanthocottus, Cottus), 180.
variabilis (Labrus), 7.
variegatus (Labrus), 10.
Vegæ (Pleuronectes), 390.
velivolans (Lepidorhombus, Zeugopterus), 447, 451.
ventralis (Cottus, Gymnocanthus, Phobetor), 160.
vernalis (Merlangus), 511.
vespertilio (Lophius), 136.
Vieille, La, 7.
Vildkråks-simpa, 185.
vipera (Trachinus), 131, 266.
virens (Gadus, Pollachius), 466, 467, 500.
vitrea (Perca, Stizostedium), 37.
vittatus (Labrus), 10.
viviparus (Sebastes), 148, 149.
Vogmar, 314, 315.
vogmarus (Trachypterus), 315.
volgensis (Perca), 37.
volitans (Exocœtus), 357, 358.
vomer (Selene), 83.
vomerinus (Lophius), 144.
Vrakfisk, 47.
vulgaris (Acerina), 41.
vulgaris (Auxis), 108.
vulgaris (Belone), 347.
vulgaris (Brosmius, Brosmus), 562.
vulgaris (Cantharus), 54.
vulgaris (Flesus), 399.
vulgaris (Gunnellus), 220.
vulgaris (Hippoglossus), 408, 409.
vulgaris (Julis), 21.
vulgaris (Limanda), 387.
vulgaris (Liparis), 284, 287.
vulgaris (Lota, Molva), 526, 532.
vulgaris (Merlangus), 487.
vulgaris (Merluccius), 515.
vulgaris (Motella, Onos), 550.
vulgaris (Perca), 26.
vulgaris (Platessa), 392.
vulgaris (Solea), 365, 371, 372, 373.
vulgaris (Sphyræna), 327.
vulgaris (Thynnus), 98.
Vålgild Torsk, 476.
Wachna, 481.
Wachnja, 481.
Weever, Great, 128,
Weever, Lesser, 131.
Whiff, 447, 448.
whiff (Lepidorhombus, Pleuronectes), 427, 447, 448, 455.
Whiting, 465, 487.
Whiting Pollack, Norwegian, 508.
Whiting Pout, 493.
Wolf, 46.
Wolf-fish, 232.
Wrass, Ballan, 7.
Wrass, Comber, 7.
Wrass, Rainbow, 21.
Wrass, Scale-rayed, 5.
Wrass, Small-mouthed, 14.
Wrass, Striped, 10.
Wrasses, Parrot, 2.
Wreck-fish, 47.
Xiphias, 117, 118.
Xiphiidæ, 70, 116.
Zachirus (Glyptocephalus), 386.
zebra (Brachirus), 371.
Zenarchopterus, 342.
Zenidæ, 70, 126.
Zenopsis, 305.
Zeugopterus, 426, 456.
Zeus, 304, 305.
Zoarces, 211.
Ångerpiga, 390.
Öienpaal, 512.

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PISCES TELEOSTEI

(OSSEOUS FISHES).

Skeleton complete and, usually, ossified. Olfactory organ double. The optic nerves only decussate, and do not form a chiasma. Only two valves[a] in the arterial bulb.

In addition to their other characteristics, the comparatively lax arterial bulb of the two-chambered heart, from which the blood passes to the arteries of the branchial arches, and the simple decussation of the optic nerves, which, at their exit from the brain, only cross each other without fusing together their fibres, place these fishes lower on the scale of development than the Chondrosteans, Chondropterygians and the Ganoids (the latter unrepresented in the Scandinavian Fauna), which orders come nearer the Batrachians. On the other hand, the double olfactory organ, which the osseous fishes possess in common with the above-mentioned higher orders, separates them from the Cyclostomes, which are represented in Scandinavia by the lampreys, while the skull places them as well as all other true fish, as vertebrates, high above the Cirrostomes, the sub-class to which the lancelet belongs. Thus, while it is true that the osseous fishes do not occupy the highest rank among fish with respect to their general degree of development, regarded as fish they are nevertheless, above all the others, distinctly marked by their usually ossified skeleton and the manifold development of their organs to meet the requirements of aqueous life.

TELEOSTEI PHYSOCLYSTI.

Osseous fishes with the air-bladder, if present, closed (without pneumatic duct) at least in the adult.

The air-bladder, which corresponds anatomically, though not physiologically, to the lungs of the higher vertebrate animals, is originally an outgrowth of the digestive canal, but loses in the most highly developed fishes its immediate connection with this canal. Such a change is in itself a sufficient indication of a more advanced degree of development, and has consequently full claim to be regarded in a systematic scheme of arrangement. In certain cases where the air-bladder is absent — as, for instance, in the common mackerel, whereas it exists in the so called Spanish mackerel, which is nevertheless a very closely allied species — we must be guided by other resemblances to assign the fish its place among the Physoclysts.

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[a] Some Clupeoids form an exception, as they retain a rudiment of the Ganoid *conus arteriosus* at the base of the bulb. Cf. Boas: Om conus arteriosus hos *Butirinus* og hos andre Teleostei. Vidensk. Meddel. Naturh. For. Kbnhvn 1879—80, p. 333. Generally too rudiments are to be found of two more valves in the arterial bulb between the others; but in *Orthagoriscus mola* (cf. Wellenbergh: Observ. Anat. de Orth. mola, Lugd. Batav. 1840) these rudiments are true valves.

PHYSOCLYSTI ELEUTHEROGNATHI.

Physoclysts with the edge of the upper jaw composed only of the comparatively free intermaxillary bones, with the branchial arches complete and the branchial laminæ pectinated. No externally visible interclavicles.

With the advancement of development in the Teleostei the intermaxillary bones assume a more and more important position in the formation of the upper jaw. In the Eleutherognates the intermaxillary bones remain independent, whereas in the Plectognates they are united with the superior maxillaries, at the same time as the divisions of the lower jaw, the dental and the angular, coalesce into one whole. The Plectognates, which are represented in the Scandinavian Fauna by only two rare species, *Balistes* and *Orthagoriscus*, are well qualified, as far as this character goes, for a higher place in the system, the coalescence of the jaw bones being an unmistakable sign of a more highly advanced degree of metamorphosis. However, in other respects, — in the marked development of the exoskeleton, combined with the slight ossification of the endoskeleton — they have retained so much that reminds one of more ancient types, that hitherto they have generally been placed lowest among the Teleostei. It has been left to modern systematists to correct this mistake, and to show their close relationship to the most typical Physoclysts[a]. The Eleutherognates differ from the *Hemibranchii*, which are represented in our Fauna by the sticklebacks, in the completeness of their branchial arches as well as in the absence of interclavicles, and from the *Lophobranchii*, in our Fauna the group of the pipefishes, in the pectination of their branchial laminæ.

In the Eleutherognates the strengthening of the fins, especially of the dorsal and anal, by an increased number of spinous rays, is one of the most regular indications of an advanced stage of piscine development. Consequently from the time of Cuvier onwards the spinous-rayed Eleutherognates or *Acanthopterygii* have generally been placed highest among the Teleostei. This division of the Eleutherognates may be distinguished by the fact *that in the front part, at least, of the dorsal, anal and ventral fins there are simple unarticulated and undivided hard rays.* Foremost among these fishes we shall place a series of families of which the well-known wrasses may be considered typical.

LABROMORPHI.

Eleutherognates with the lower pharyngeals united to each other.

In the systems of Johannes Müller and most subsequent ichthyologists, these fishes have been named *Pharyngognathi*[b] in consequence of the union of the lower pharyngeals, a character by which Artedi also defined his genus *Labrus*,[c] and Cuvier the family *Labroides*[d]. The rest of the Eleutherognates might therefore well be called *Lysipharyngii*, if there be need of a corresponding name for them, though the difference does not seem to be of sufficient importance to justify us in referring the Pharyngognates to a special order, as Müller and Günther have done[e]. However, the Pharyngognates possess one mark of a special modification of the Acanthopterygian type, which appears only occasionally in the Lysipharyngii. This is the fact that the masticating power of the mouth and pharynx is increased both by the union of the lower pharyngeals and by the stronger teeth with which these bones as well as the jaws are armed. This apparatus has reached its highest point of development in the exotic family of Parrot-wrasses, as represented by the *Scarus* and similar forms.

If furthermore we have regard to the great splendour of colour by which many of the Pharyngognates are distinguished, we seem fully justified in following the lead of Sundevall,[f] who was the first to place the Pharyngognates highest, as far as development goes, in the Acanthopterygian series, though they are not of course in every respect qualified for this position.

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[a] Cope, Trans. Amer. Philos. Soc., Philad., n. ser. vol. XIV, art. V, p. 458.

[b] Müller: *Über den Bau und die Grenzen der Ganoiden und uber das naturliche System der Fische*, Abh. d. Berl.-Akad. 1844, Phys. Kl., p. 199.

[c] Artedi: *Genera Piscium*, p. 33.

[d] Cuvier: *Règne Animal*, nouv. éd., Tome II, p. 254.

[e] Müller, l. c. and Günther, Brit. Mus. Cat., Fish., vol. IV, p. 1.

[f] In the arrangement of the collection of fishes in the Royal Museum of Stockholm. Cf. Cope, l. c., where the same view is taken.

As is the case with organic life generally in the warmer regions of the earth, so in the tropical seas the Pharyngognates attain to their full development of form. «Anyone,» says Fries, »who is out fishing on our western coast and for the first time sees a wrasse taken on the hook, may fancy himself transported, as if by a stroke of magic, to tropical shores, and, watching in intense excitement, expect at the next bite to see one of the paradoxical creatures which so abound in those waters. But the illusion is soon past, vanishing as the line is pulled in, and is followed by nothing but an ordinary cod or flounder.»

In their real native waters the Pharyngognates are very numerous in genera and species. As early as 1862 Günther described no less than 647 species, distributed among 4 families and 74 genera, and mentioned in addition a great many of which he had no personal knowledge. Very few of them, however, belong to the Scandinavian Fauna; and all the Scandinavian species fall under one family.

Fam. **LABRIDÆ.**

The form of the body perch-like, the scales cycloid, the soft-rayed part of the anal fin like that of the dorsal; the ventral fins thoracic with one spinous and 5 soft rays, the branchiostegal rays 5 or 6, the fourth row of branchial laminae simple, with no slit behind it, the pseudobranchiæ and air-bladder normal, the palate without teeth, the jaw teeth strong. The pyloric appendages and the blind sac of the stomach are wanting.

There is much in the form of the wrasses that reminds one of the genus *Serranus* among the perches, but the cycloid, edentulous, and comparatively thin scales and the toothless palate of the former separate them distinctly from the latter. Their teeth are strong, those of the jaws being pointed or sometimes rather obtuse; the pharyngeal teeth are blunt and often flat and crowded like the stones of a pavement; the upper and lower sets work well against each other, as the upper pharyngeals articulate with the basilar part of the occipital bone. Thus the jaw-teeth seize the prey, while those of the pharyngeals are used in grinding it. The dental equipment of the wrasses is indeed characteristic of their manner of life, as they live upon the crayfish and mollusks of the rocks and sea-weed, which they usually crush, though sometimes the shells are to be found intact in the digestive canal. The protractile jaws with the thick swollen lips which have given rise to the name *'labroid'* or *'lip-fish'* are also characteristic of their habits. That which enables us in most cases immediately to distinguish a wrasse, as well as other Pharyngognate Acanthopterygians, from a perch, is the prolongation of the fin-membrane into a flap behind the point of each spinous ray, the *pinna ramentacea* of Linnaeus. However, this flap is said to be wanting in some species belonging to this family, while, on the contrary, it exists in several of the Serrani. The ventral fins are thoracic, i. e. they lie a little farther back than the base of the pectoral fins; but the pelvic bones with which they articulate are long and project to the lower point of the clavicles, or the front end of the pectoral girdle. The fourth pair of branchial arches carries only one row of branchial laminae, and the slit, which otherwise separates this pair of arches from the lower pharyngeals and the back wall of the gill-orifice, is closed. The digestive canal is peculiarly simple: the stomach which in many forms is scarcely perceptible as a special enlargement of the canal, has no blind sac, and the pyloric appendages are wanting.

The wrasses inhabit the seas of the hot and temperate regions and are not to be found within either the Arctic or Antarctic circle. They are among the chief ornaments of the coral reefs and the algæ which fringe the solid rocks. Some species however are also to be found among weed and stones where the bottom is of a looser nature. They are neither pelagic nor deep-sea fish, and are not often to be met with in more than 30 fathoms. In disposition the wrasses are lively and sociable, though they congregate in small bodies only and not in real shoals. The male and female often differ very much in colour, and during the spawning season the former are especially gay and showy. Their colouring is however very fugitive: their brilliancy, which in life is variable, entirely vanishes soon after death. A number of observations have been made which suggest that the monogamic principle is, to a certain extent, practised among these fish; each male is said to select and associate with his own female, at least during the spawning season; and some species are said to build nests of seaweed for their ova[a]. To man the wrasses, being fish of good flavour and easy of digestion, are of considerably alimentary value, but in Sweden they are seldom caught in any great quantity, indeed with rod and line only, and are not held in very high esteem. In southern countries the case is different: and the ancient Greeks and Romans have handed down to us the most eloquent panegyrics of these fish. Their highest esteem seems to have been given to a Mediterranean fish of the genus *Scarus*, as to which ARISTOTLE cites the popular belief, that it was the only fish that chewed the cud after the manner of certain land-animals, while OPPIAN adds that in its amatory pursuits it is the most ardent of fishes, insomuch that, by the help of a captive female attached to a line, numbers of males may be enticed into the nets. At the same time it was held to be a very sagacious fish, capable even of helping its captured fellows by drawing them through the meshes of the net. According to SELEUCUS of Tarsus it was the only fish that indulged in sleep and was for this reason not to be caught at night[b]. According to PLINY it was introduced into Italy from Greece by OPTATUS ELIPERTIUS during the reign of the Emperor CLAUDIUS. Physicians too considered it the best and most wholesome of food. The fat of its intestinal canal was especially esteemed; and we have a line of the Greek Comic poet EPICHARMUS which states that it was not lawful for the gods themselves to throw away its excrement[c]. In hot countries the wrasses are more numerous and easier to catch, and are therefore fished for more assiduously. Even the savages of the Polynesian islands and Australia, in whose waters some of the wrasses attain a weight of as much as 50 pounds, are not slow to avail themselves of this source of food. Armed with their long wooden spears, which are furnished with one or sometimes several points, they keep watch upon the rocks for these shy fish and may be seen standing for hours together silent and motionless till the moment of the cast comes. The Europeans too, who live in these parts, set a high value on the large wrasses, and catch them with hook and line, using crabs as bait. In the Mediterranean, according to ELIAN, the 'parrot-wrasses' (a species of *Scarus*) were caught in old times with baits of coriander and parsnip.

The wrasse family is especially well represented, as far as variety of form goes, in the East Indian Seas, in connexion with which it has been excellently described by the Dutch naturalist BLEEKER. GÜNTHER makes six sub-divisions of the entire family, only two of which are represented in the Scandinavian Fauna — the typical wrasses (*Labrina*), which possess the extreme number of dorsal fin rays together with free (not united) jaw-teeth, and the Rainbow-wrasses (*Julidina*), which have 12 spinous rays at most in the dorsal fin, the jaw-teeth also free, and the pharyngeal teeth not confluent. Those of the Scandinavian species which belong to the first subfamily may be distinguished by means of the following scheme:

I: Top of the head covered with scales, as is also the interorbital space .... *Labrus* (*Acantholabrus*) *Palloni.*
II: Interorbital space naked.
  A: Number of scales in the lateral line more than 40, above the lateral line 6 rows of scales at least.
    a: Number of spinous rays in the dorsal fin at least 19 .... *Labrus berggylta.*
    b: Number of spinous rays in the dorsal fin at most 18 .... *Labrus mixtus.*
  B: Number of scales in the lateral line at most 40. Above the lateral line not more than 4 rows of scales.
    a: Number of spinous rays in the anal fin more than 3 .... *Labrus* (*Centrolabrus*) *exoletus.*
    b: Number of spinous rays in the anal fin at most 3.
      α: The smallest depth of the tail at least 85 per cent of the base of the anal fin *Labrus* (*Ctenolabrus*) *rupestris.*
      β: The smallest depth of the tail at most 75 per cent of the base of the anal fin .... *Labrus* (*Crenilabrus*) *melops.*

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[a] *Labrus berggylta*, *L. massa* and *L. paro*, GERBE, Rev. Mag. Zool., ser. 2, Tom. XVI (1864) pp. 255, 273, 337; MOREAU, *Hist. Nat. Poiss. Fr.*, Tom. III, p. 102.

[b] This statement as to sleep has been confirmed by MÖBIUS and HEINCKE (*Fische der Ostsee*, p. 72) in connexion with a northern species (*Labrus rupestris*), which, when kept in an aquarium, seeks a sleeping place at night and lays itself down to rest on one side.

[c] Cf. CUV. et VAL. *Hist. Nat. Poiss.* p. 133 etc. Epicharmus apud Athenaeus, VII, 114; σκάρους, τῶν οὐδὲ τὸ σκᾶρ θεμιτὸν ἐκβαλεῖν θεοῖς.

GENUS LABRUS.

Dorsal fin of a uniform depth or deeper behind than in front. Cheeks and gill-covers scaly. Jaw-teeth free (not united).

THE SCALE-RAYED WRASSE (SW. BRUNSNULTRAN).

LABRUS (ACANTHOLABRUS) PALLONI.

Top of the head scaly, as well as the interorbital space. Dorsal and anal fins scaly at the base. More than 40 scales in the lateral line. Cheeks with 5[a] rows of scales under the eyes. Several rows of teeth in the upper and lower jaws, within the outer row. In the dorsal fin at least 20 spinous rays, in the anal 5[b].

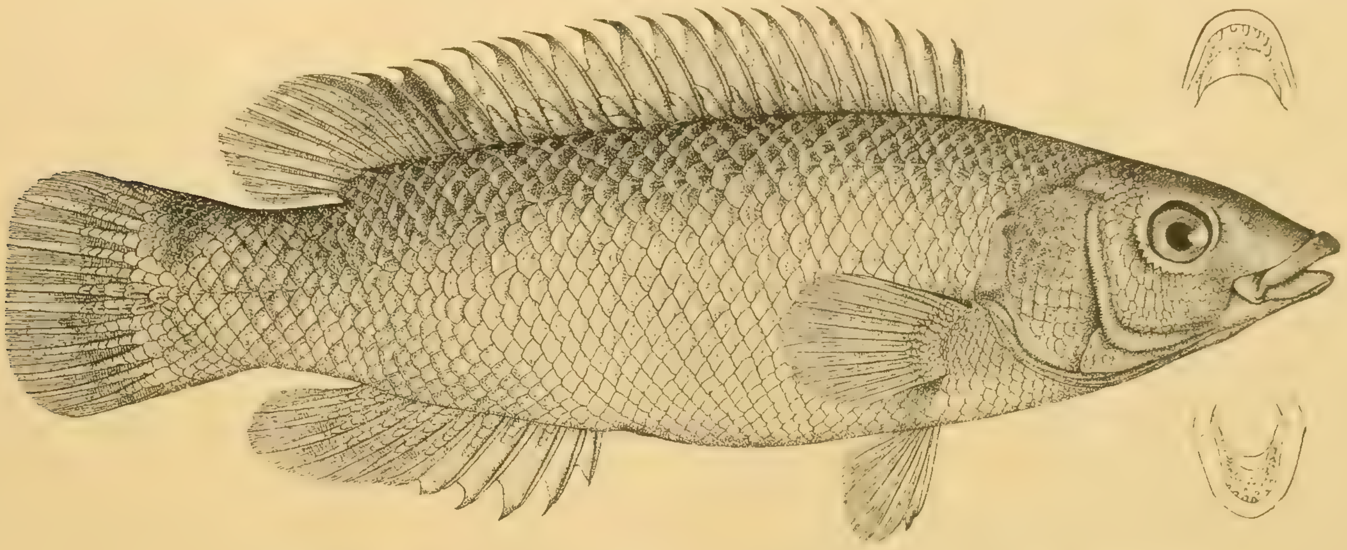

Fig. 1. Scale-rayed Wrasse (*Labrus Palloni*) from Kragerö (Norway). $^{2}/_{3}$ of the natural size.

R. br. 5; *D.* $^{21}/_{8}$[c]; *A.* $^{5}/_{8}$; *P.* $^{2}/_{13}$; *V.* $^{1}/_{5}$; *C.* $x + 13 + x$; *L. lat.* 40—42[d].

Syn. *Lutjanus Palloni*, RISSO, *Icht. de Nice*, p. 263; CUV., VAL. (*Acantholabrus*), *Hist. Nat. Poiss.*, XIII, p. 243, fig. 375; SMITT, *Nord. Familjebok*, I, 281; LILLJEBORG, *Sv., Norg. Fiskar*, I, p. 447.

Crenilabrus exoletus, RISSO, *Hist. nat. pr. prod. Eur. mér.*, III, p. 329.

Labrus luscus, COUCH, Loud. Mag. Nat. Hist., V, pp. 18 and 742 (fig. 121).

Acantholabrus Couchii, CUV., VAL., *Hist. Nat. Poiss.*, XIII, p. 248; ÖBERG, *Öfvers. Vet.-Akad. Förh.* 1870, No. 4, p. 391.

Acantholabrus imbricatus, LOWE, Proc. Zool. Soc. 1839, p. 86 and 84.

If any of the Scandinavian wrasses deserve to be distinguished from the others as a separate genus or subgenus, this species, first and foremost, claims that distinction. It is the only one that has scales extending over the top of the head, though there they are small, over the neck and the inter-orbital space; the only one that has an angular space, covered with rows of scales, on the membrane between each pair of rays in the dorsal and anal fins[e]; and lastly the only one that has 13 branched rays in the caudal fin. We cannot however assign so great an importance to these distinguishing points, when we see that similar variations occur in other genera of this same family. The forehead is scaly in some species of the tropical genus *Cossyphus* (a kind of Rainbow Wrasse) of the group *Julidina*, while in others it is naked[a]. Again, the covering of scales at the bases of the dorsal and anal fins, which is connected with the development of the fin-sheath that appears in certain genera of the wrasses and conceals the fins to a greater or less extent, displays the same want of uniformity in the different species of the tropical genus *Callyodon*[b]. The structure of the caudal fin might perhaps supply us with a more distinct generic character; but we shall find below, in the Rainbow Wrasse, a variation in this respect also. Such a diversity of form within the limits of the other genera confirms, with regard to this species also, the opinion of FRIES, SUNDEVALL and LILLJEBORG that all the Scandinavian wrasses may be included in one genus.

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[a] Sometimes 4, according to MOREAU.

[b] Sometimes 4 and sometimes 6; cf. MOREAU, *Hist. Nat. Poiss. Fr.*, III, p. 140, and DAY, *Fish. of Gt. Brit. and Irel.*, p. 266.

[c] $^{20}/_{9}$ or $^{21}/_{8}$, according to VALENCIENNES (CUV., VAL., l. c.) and GÜNTHER (*Cat. Brit. Mus., Fish.*, IV, p. 91 and 92). Our specimen from Hitterö is abnormal in one respect, the ninth spinous ray in the dorsal fin being double, i. e. on the left side there is a superfluous ray, furnished with basal scales and with membrane joining the ninth ray, which on this side has no basal scales.

[d] In younger specimens 38, according to LILLJEBORG, l. c.

[e] Hence COUCH gave this species the name of Scale-rayed Wrasse.

In other respects, both in the number of scales in the lateral line and of spinous rays in the dorsal fin, the Scale-rayed Wrasse most closely resembles the following species (*Labrus berggylta*). But even in outward appearance it differs from this species, as well as from the Blue-striped Wrasse (*Labrus mixtus*), as it has only 4 rows of scales above the lateral line and the scales on the cheeks are larger. The body is noticeably elongate, and its greatest depth, about $^{1}/_{4}$ of the length[c], is a little less than is the case with the Ballan Wrasse, so that in this respect it more closely resembles *Labrus mixtus* or *Labrus rupestris*. The least depth of the body is about $^{2}/_{17}$ of the total length[d], which in the Royal Museum's specimen from Hitterö in Norway is 264 mm. Its greatest thickness of the body is about $^{1}/_{2}$ of the greatest depth. The relative length of the head is about the same as in the Ballan Wrasse, being about $^{2}/_{7}$ of the total length[e]. The relative length of the snout is also nearly the same as in the Ballan Wrasse; but the eyes are considerably larger, as is natural in a fish that apparently lives in deep water. The horizontal diameter of the eye, which in older specimens is about $^{2}/_{3}$ of the least breadth of the interorbital space[f], is about $^{5}/_{28}$ of the length of the head[g]. The relative length of the dorsal fin is only slightly greater than in the Ballan Wrasse, and the length of its base is about $^{8}/_{17}$ of the total length[h]; but the anal fin is comparatively much longer and more nearly corresponds to that of *Labrus mixtus*, its base being about $^{5}/_{28}$ of the total length[i] and about half as much again as the least depth of the tail[j]. These fins are also fairly deep: the length of the longest spinous rays in the dorsal fin is about $^{1}/_{3}$ of the length of the head or $^{3}/_{4}$ of the least depth of the tail[k]. That which deserves special attention, however, is the shortness of the first ray of the dorsal fin. This peculiarity, as well as the somewhat high position of the lateral line on the back and its sudden downward sweep at the termination of the dorsal fin, the arrangement of the jaw-teeth, and the crenulated edge of the preoperculum, may all be observed in our figure[l]. The lips are fleshy and thickly covered with papillæ, which also fringe the sides of the longitudinal folds beneath the lateral parts of the upper-lip. The tongue is flat with sharp sides.

The colouring of the Scale-rayed Wrasse seems to be highly variable, to judge by the descriptions and figures of RISSO[m] and COUCH[n]. ÖBERG describes it as follows: — «The colour of the body olive-brown on the back, on the belly lighter and yellowish without spots or stripes. The fins yellowish; a blackish-brown spot at the meeting of the soft and spinous parts of the dorsal fin, and a similar spot on the upper margin of the base of the caudal fin; the upper part of the spinous rays of the dorsal fin blackish-brown.» These spots, as well as the blackish-brown colour of the membranous flaps behind the spinous rays of the dorsal and ventral fins, are still distinct in the specimen preserved in alcohol, and are shown in the figure. In this specimen there appear too, on the inferior part of the gill-cover and on the anterior parts of the suboperculum and the belly, especially at the bases of the pectoral fins, distinct traces of the golden gloss which this fish possesses in VALENCIENNES' figure.

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[a] Cf. BLEEKER, *Atlas Ichthyologique*, I, Labr., p. 158.

[b] Cf. BLEEKER, l. c. p. 12.

[c] *Obs.* Hereafter in this work, where nothing else is remarked, the length of the body always means the distance from the tip of the nose to the extremity of the middle caudal rays. In the Hitterö specimen the depth is 24.2 % of the length.

[d] In the Hitterö specimen 11.7 %.

[e] 27.7 %.

[f] 65 %.

[g] In the Hitterö specimen 17.8 %.

[h] 47 %.

[i] 17.8 %.

[j] In the Hitterö specimen 151.6 %.

[k] 77.4 %.

[l] The figure also shows how the most superior and the most inferior of the caudal rays that extend to the extremity of this fin, are branched. The difference between the Scale-rayed Wrasse and the other Scandinavian species in this respect is expressed in the fin-formula given above. In the formula for the caudal fin (*C*) x stands for the number (very seldom uniform and almost impossible to fix without dissection) of supporting rays at the superior and inferior edges of the caudal fin, as well as for the two undivided rays, one at the superior and one at the inferior edge, which are really supporting rays, but usually extend to the extremity of the fin.

[m] L. c. Cf. also VALENCIENNES, l. c.

[n] *Hist. Fish. Brit. Isl.*, III, p. 38, tab. CXXIX.

The Scale-rayed Wrasse belongs to the fauna of the Mediterranean and the Atlantic. In the Atlantic it is found from Madeira to the south coast of Norway. However, as it is more of a deep-sea fish than the rest of the Scandinavian wrasses, it is more seldom met with. The specimen in the Royal Museum, the only one that has been observed up to the present on the coast of Scandinavia, was acquired by DR. P. ÖBERG during a visit to Hitterö near the town of Flekkefjord in Norway, in the summer of 1869. It was caught at a depth of 30 fathoms. On the English coast only two specimens are known to have been taken, the one at a depth of 50 fathoms. Off the coasts of Portugal and Madeira too it is very rare, according to LOWE and STEINDACHNER[a]. MOREAU also says that it is very seldom met with in the Mediterranean. It can therefore hardly possess any value as an article of food.

THE BALLAN WRASSE (SW. BERGGYLTAN).

LABRUS BERGGYLTA.

Plate I, fig. 1.

The back of the head and the forehead naked. Number of scales in the lateral line more than 40. At least 6 rows of scales above the lateral line. Only the posterior part of the interoperculum scaly. The cheeks covered with small scales; at least 6 suborbital rows of scales. Number of spinous rays in the dorsal fin at least 19. Length of the snout (when the mouth is closed) less than either the greatest thickness of body or the postorbital length of the head. Least depth of the tail more than $^4/_5$ of the base of the anal fin[b]. *Streaks on the head red.*

R. br. 5; *D.* $\frac{19-21}{1+10\,\mathrm{l}.\,9.\,\mathrm{l}.\,8}$; *A.* $\frac{3}{1+7\,\mathrm{l}.\,8}$; *P.* 2 13; *V.* 1 5: *C.* $x + 11 + x$; *L. lat.* 41—47.[c]

Syn. *Labrus Berggylta*, ASCANIUS, *Ic. rer. nat.*, I, p. 3, tab. I: MÜLLER, *Zool. Dan. Prodr.*, p. 46 (Berg-galt); CUV., VAL., *Hist. Nat. Poiss.*, XIII, p. 20; KROYER, *Danm. Fiske*, I, p. 476 (*Berggylta*); MALM, *Gbgs, Boh. Fn.*, p. 475; WINTHER, *Prodr. Ichth. Dan. mar.*, Naturh. Tidskr., 3, XII, p. 25; LILLJEBORG, *Sv., Norg. Fisk.*, vol. I, p. 419.

Ballan Wrasse, PENNANT, *Brit. Zool.*, ed. 1, III, p. 216, tab. XLIV: WALB., *Icht. Art.*, III, p. 259 (*Labrus Ballan*): COUCH, *Hist. Fish. Brit. Isl.* III, p. 24, tab. CXXV (*Ballan Wrass*).

Comber, PENNANT, l. c. p. 221, tab. XLVII, fig. 122: GMEL., *Syst. Nat. Lin.*, p. 1297 (*Labrus Comber*); COUCH, l. c. p. 32, tab. CXXVI, fig. 2 (*Comber Wrass*).

Labrus maculatus, BLOCH, *Naturg. Ausl. Fische*, VI, p. 17, tab. CCXCIV; NILSSON, *Prodr. Ichth. Sc.*, pag. 74; FR., EKSTR., WRIGHT, *Skand. Fiskar*, ed. 1, p. 11 et 43, tab. 2; NILSS., *Skand. Fn., Fisk.*, p. 261; GÜNTH., *Brit. Mus. Cat., Fish.*, IV, p. 70; DAY, *Fish. Gt. Brit., Irel.*, I, p. 252, tab. LXX & LXXI.

Labrus Aper, RETZIUS, *Fn. Suec. Lin.*, p. 335.

Labrus lineatus, DONOVAN, *Nat. Hist. Brit. Fish.*, IV, tab. LXXIV; nec PENN. l. c., nec NILSS., *Prodr.;* DAY, l. c., p. 253, *Labrus Donovani*, CUV., VAL., l. c. p. 39; DAY, l. c.

Labrus tancoides et *Neustriæ*, LACÉPÈDE; *Labrus tinca*, SHAW; *Labrus cornubiensis*, COUCH; *Labrus variabilis*, THOMPSON; vide GÜNTHER, l. c. et DAY l. c.

Labrus pusillus, JENYNS et *Crenilabrus multidentatus*, THOMPSON; (juvenes) vide GÜNTHER, l. c. et DAY, l. c.

La Vieille, DUHAMEL, *Tr. d. Pèches*, part. II, vol. III, sect. IV, cap. III, p. 34, tab. VI, fig. 1; *La Vieille commune ou Perroquet de Mer*, CUV., VAL., l. c.

In Scandinavia the Ballan Wrasse attains a length of from 300 to 370 mm., and is thus one of the largest species belonging to this genus which we possess. The length of the head is about $^1/_4$ of the total length; the greatest depth of the body from $^2/_7$ to $^4/_{13}$ and the least about $^1/_8$ of the length[d]. The head is triangular and suddenly comes to a point. The mouth is small; the jawbones are completely concealed by large, thick lips which project some way in front of them. On the upper jaw the lips are double, the one lying above the other. The superior is the shorter, and really forms a continuation of the skin which covers the suborbital bones; the inferior is longer and more fleshy, has deep longitudinal folds underneath, and starting from the intermaxillary, forms with the under lip a distinct corner at each side of the mouth. A broad flap hangs on either side of the under lip. This formation of the mouth gives it some resemblance to a swine's snout, and is the origin of the name Berggalt (»rock-boar»), Berggylta, etc. The cavity of the mouth is narrow, and has palatal curtains (transverse folds or *vela*) above and below which are opposite each other and seem intended to prevent the escape of water or food through the mouth in the act of breathing or swallowing. The tongue is thin, and at the tip flat and attenuating. When the mouth is open, the upper jaw projects considerably, as the long nasal processes of the intermaxillary bones glide forward on the ethmoidal and frontal bones. In both jaws there is a row of small, conical teeth, largest in front and gradually diminishing in size as they recede on either side. Within this row in the anterior part of both jaws is a row of much smaller teeth which project very slightly or are concealed by the gums. There are no other teeth in the mouth itself, either on the tongue, the palatine, or the vomer; but in the pharynx there are two small *upper* pharyngeals (each composed of three bones), which articulate with the bottom of the skull, and one trilobate *lower* pharyngeal, all three densely set with small, obtuse, conical teeth. The eyes are circular, and their diameter is from $^1/_5$ to $^1/_7$ of the length of the head. They are placed fairly high, their inferior edge being above a line drawn from the apex of the upper jaw to the middle point of the tail. The nostrils are small, and have two distinct openings on each side, the anterior being prolonged into a dermal canal with widened mouth. The sides of the head are covered with scales, with the exception of the preoperculum itself, the edge of the preoperculum and the anteorbital region. It is true that in mature specimens the edge of the preoperculum is not apparently denticulated, but on taking away the skin one finds on the bone itself fine serrations, which are also indicated by some narrow strips of skin originating in the middle of the edge. In younger specimens the whole edge of the preoperculum is sometimes sharply and clearly crenulated, a fact which has caused such specimens to be regarded as a distinct species, under the name *Crenilabrus multidentatus*. The operculum is large, its depth is greater than its length, and the posterior margin forms two corners and is continued by a flap of skin which runs out into a fine point at the lower corner. The interoperculum is also large and distinctly visible under the preoperculum; it has some scales on the posterior portion in the top corner. There are 5 branchiostegal rays, and the branchiostegal membranes are united by a thick integument which hangs quite free round the breast and is attached to the isthmus only by its front point.

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[a] *Ichth. Span. Port.*, Sitzb. Akad. Wien, Math. Naturw. Cl. LVII, Abth. I, p. 699.

[b] The least depth of the body, in proportion to the length of the base of the anal fin, increases with age. In 6 measured specimens the least depth of the tail was on an average 91.5 % of the base of the anal fin, the minimum being 82 %. the maximum 99.4 %.

[c] The variations of the fin formula are explained in the text.

[d] The least depth of the body (least depth of the tail) in proportion to the length of the body increases with age; in 6 specimens it was on an average 12.5 %, the minimum being 11.8 %. the maximum 13.2 %.

The body is oval and laterally compressed; it is completely covered with large imbricate scales, which are thin, have an entire edge and are not marked exteriorly with any large streaks. The lateral line is generally composed of from 42 to 44 comparatively small scales pierced by a horizontal tube, which are not contiguous but separated by the scales of the two nearest rows. It is consequently not very distinct, and it runs parallel with the curve of the back as far as the extremity of the dorsal fin where it makes the same downward curve as the dorsal line. Above the lateral line there are 6 or 7 rows of scales and below it 13 or 14. The vent is a little behind the middle point of the body.

The dorsal fin commences just over the base of the pectoral fin and ends in a sharply rounded corner just where the back slopes towards the tail. At first its edge is slightly convex, then somewhat concave, rising again at the beginning of the soft-rayed portion. Its anterior part generally consists of 19 or 20 spinous rays between which the membrane is serrated at its edge and prolonged behind each ray except the last into a long, lancet-shaped flap. In the posterior part are 10 or 11 branched and articulated soft rays, the first of which however is, as a rule, simple at the point, while the last is divided to the base, apparently forming two separate rays. In the anal fin there are 11 or 12 rays, the first three of which are short and spinous, the others longer, soft and articulated. Behind each of the first two spinous rays the fin membrane is serrated as in the dorsal fin. In the same way the first soft ray of the anal fin is often simple, while the last is always deeply cleft. The fin is rounded at its extremity like the dorsal fin. In length it is about $^1/_7$ of the total length[a]. The pectoral fins are thin, with distinct rays and rounded point; they consist of 15 rays, the first of which is short and, like the next ray, undivided at the point; the others are branched and thick. The ventral fins, which are placed a little behind the pectoral and rounded at the extremity in the same way, consist of 1 spinous ray and 5 articulated soft rays. The caudal fin is straight (neither concave, nor convex) at the extremity, with slightly rounded corners and broad base. It consists of 11 thick branched rays with one undivided ray, extending to the hinder margin of the fin, on each side of them, and a number of simple supporting rays, three of which may generally be distinguished without difficulty. Between the roots of the former rays the fin-membrane is covered with imbricate scales.

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[a] The relative length of the base of the anal fin diminishes with age. In 6 measured specimens it was on an average 13.7 % of the total length; the minimum was 12.4 %, the maximum 14.5 %.

As the colouring of this species is very diversified and variable, it is by no means easy to give a description applying equally well in all cases. As a rule we may divide the Ballan Wrasse into two varieties, the *dark* and the *light*. The former is represented in the figure. Its prevailing colour is green, which becomes lighter towards the belly and there has a bluish tinge. On the sides are several large dark spots, which are faintly marked and vary in number, size, and colour. The scales are edged with orange, on the lower part of the sides inclining to yellow and higher up to brown. Under the chin and breast irregular wavy stripes of the same orange tint. The iris green with an orange ring next the pupil and another similar ring round the outer margin. The dorsal fin green with a network of chocolate-brown spots between the rays. The rays of the anal fin orange, and the fin covered with round blue spots on a russet ground. The first ray and the membrane of the ventral fins bright yellow, the other rays blue with the points bright yellow, and here and there a dash of the same colour. The caudal fin green with a bluish tinge towards the base, and covered with a network of russet lines. The rays of the pectoral fins orange, and the fins themselves spotted with blue, especially at the base. The principal colour of the *lighter variety* is yellowish brown with brown spots; the belly is whitish, and the edges of the scales brown. There are three brown spots on the posterior part of the back which are especially remarkable for their size; the first and largest is just below the middle of the dorsal fin, the last and next in size at the end of this fin. To this variety belong all younger specimens, and between the two varieties there are innumerable states of transition, which are probably due to local circumstances and do not depend on the season of the year or the sex of the fish.

The intestinal canal is very simple: it consists of a tube which decreases in width with almost perfect regularity, and there is no stomachic dilatation, no externally distinct pylorus, and no pyloric appendages. This intestinal tube has thin walls with the inner surface covered with a network of folds, and widens suddenly into a fairly large rectum. The spleen large and triangular. The liver consists of three lobes, the middle one very large and lying lengthwise in the belly a little to the left, the two others, one on each side, very small and short. The gall-bladder small and narrow, and of almost uniform width. The air-bladder large but short, and fastened by a strong membrane to the upper wall of the abdominal cavity. The ovaries and testicles double.

On the coast of Norway up to Bergen and in the island-belt of Bohuslän the Ballan Wrasse is not rare, though seldom met with in any considerable number. It is also found along the whole west coast of Europe and the north-western extremity of Africa, as well as in the Mediterranean. In the western parts of the Baltic it is rare, but has been observed several times; and from the fishing-station of Kivik in Scania Lector L. J. WAHLSTEDT has obtained a specimen 260 mm. in length, which was taken in the beginning of November, 1878, and is now in the Royal Museum.

The Ballan Wrasse generally remains close to the steepest cliffs and selects a place of refuge at their foot. Here it confines itself to water of a middling depth, varying to some extent according to the age of the fish. The young fishes may often be seen in two feet of water, seeking their food and at the approach of danger concealing themselves among the seaweed which grows on the rocky bottom. The older wrasses live in deeper water, but may be met with at a depth of from 6 to 10 fathoms. They have their favourite haunts in the island-belt where one is always sure of finding them, while at other spots, apparently quite the same in nature, one looks for them in vain. Thus, in the inmost part of the island-belt and on the outer edge, at least to the seaward side of the rocks, they never occur. Their food consists of small fishes, crayfish, and mollusks.

The body of the Ballan Wrasse is, as we have seen, fairly thick and plump; its flesh is white, firm, and of good flavour, though a little sweetish. In Bohuslän it is little esteemed, and in many places is only eaten by the poorer part of the population who first split the fish and then dry it in the sun. Consequently there is no special method of fishing for the Ballan Wrasse, but it is generally taken by accident on the *'dörje-hook'* (a kind of hook used in cod-fishing) or in the herring-nets. «The 'dörje-hook',» says MALM (l. c.), «may be used to the best advantage at a depth of from 12 to 18 fathoms beneath sheer cliffs with piles of stones lying at their base. One must avoid drawing in the line as soon as the fish bites, for in that case one generally loses both hook and fish, as the wrasse darts into its hiding-place among the rocks or into a fissure of the cliff the moment it has taken the bait. Only by cautiously taking in a little line now and then one can tire out and eventually secure the fish. By this method I have often seen a fisherman take dozens of Ballan Wrasses a foot in length, and an occasional Striped Wrasse, within a few hours.» Else, if one is anxious to obtain specimens of this fish, a small seine may be used with the greatest effect, for in a favourable spot one may often secure several at the first haul.

In Bohuslän the most common name for this fish is *Bergsnultra*, but, as some of the smaller species which have no popular name are included under this appellation, we have thought it best, in order to avoid confusion, to adopt the other name used in the same district. In Norway the fish is called *Berggylte*, *Berggalt*, and *Söabborre* (sea-perch): ASCANIUS gives *Sökarpe* as the Danish name, and at Kullen it is said to be called *Hafskarp* (both of the latter names = sea-carp).

The figure given above is painted from a specimen caught in Bohuslän in the middle of July, immediately after its capture. The colouring of almost all fishes changes very rapidly after death, and after a short interval the appearance of the fish is so altered that it is scarcely recognizable. In most of the coloured plates included in this work the natural colours of the fish during life will be given as correctly as art can reproduce them. It may be that many, who have only seen the fish after death, will accuse the artist of having flattered nature, though he has only tried faithfully to represent her.

(FRIES, SMITT.)

THE STRIPED WRASSE (SW. BLÅSNULTRAN).

LABRUS MIXTUS.

Plate II, figs. 1 and 2.

No scales on the back of the head or forehead. Number of scales in the lateral line more than 40. Above the lateral line at least 6 rows of scales. Scales on only the posterior part of the interoperculum. The cheeks covered with small scales; at least 6 suborbital rows of scales. Number of spinous rays in the dorsal fin at most 18. Length of the snout at least as great as the greatest thickness of the body or the postorbital length of the head. Least depth of the tail less than $^7/_{10}$ of the base of the anal fin[a]. *Streaks on the head blue.*

♂ *dark green, with blue stripes, the fins and belly yellow spotted with blue.*

♀ *minium red, with 3 black spots on the posterior part of the back.*

R. br. 5; *D.* $\frac{16-18}{1 + 13 \text{ l. } 12 \text{ l. } 11}$; *A.* $\frac{3}{1 \text{ l. } 2 + 10 \text{ l. } 9 \text{ l. } 11}$;

P. $\frac{2}{14(15)}$; *V.* $^1/_5$; *C.* $x + 11 + x$; *L. lat.* 46—47.

Syn. *Labrus ossifagus*, LINNÆUS, *Syst. Nat.*, ed. X, p. 286.

Labrus exoletus, RETZIUS, *Fn. Suec. Lin.*, p. 335.

Labrus speciosus, FABRICIUS, Dan. Vid. Selsk. Skr. 1809 et 1810, p. 109.

Labrus dispar, FRIES et WRIGHT, *Skand. Fisk.*, ed. 1, tab. 37 et 38; EKSTRÖM, Gbgs Vet. Vitt. Samh. Handl. 1850, p. 38; MALM, ibid., p. 90.

Labrus mixtus, KRØYER, *Danm. Fiske*, I, p. 496 et 604; SUNDEVALL, *Skand. Fisk.*, ed. 1, p. 160; NILSSON, *Skand. Fn., Fisk.*, p. 265; COLLETT, Christ. Vid. Selsk. Forh. 1874, Tillægsh., p. 91; ibid. 1879. n:r 1, p. 61; MALM, *Gbgs, Boh. Fn.*, p. 477; LILLJEBORG, *Sv., Norg. Fiskar*, I, p. 429.

♂: *Labrus mixtus*, LINNÆUS, l. c., p. 287 (ex WILLUGHBY, p. 322 et ARTEDI, *Gen.*, p. 34; *Syn.*, p. 57); CUV., VAL., *Hist. Nat. Poiss.*, XIII, p. 43, tab. 369.

Labrus cæruleus, ASCANIUS, *Ic. rer. nat.*, cah. II, p. 5, tab. XII.

Striped Wrasse, PENNANT, *Brit. Zool.*, III, p. 218, tab. XLV; — *Labrus variegatus*, GMELIN, *Syst. Nat. Lin.*, I, p. 1294; — *Labrus vittatus*, WALBAUM, *Ichth. Art.*, III, p. 256; — *Labrus lineatus*. RISSO, *Ichth. Nice*, p. 220; NILSSON, *Prodr. Ichth. Scand.*, p. 75.

♀: *Labrus carneus*, ASCANIUS, l. c., p. 6. tab. XIII; NILSSON, *Prodr.*, l. c.

Trimaculated Wrasse, PENNANT, l. c., p. 218, tab. XLVI: — *Labrus trimaculatus*, GMELIN, l. c., CUV., Val., l. c. p. 58.

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[a] In 6 measured specimens the least depth of the body was on an average 63.3 % of the base of the anal fin; the minimum was 57.6 %; the maximum 68.1 %.

Obs. Valenciennes with some hesitation also gives as a synonym for this species *Labrus onitis*, Linnæus, *Mus. Ad. Frid.*, *prodr. Tomi Secundi*, p. 79; *Syst. Nat.*, ed. X, p. 286, ed. XII, p. 478. In the Royal Zoological Museum in Stockholm there is a specimen bearing the name *Labrus onitis*, which was brought there together with the rest of the collections from Drottningholm and is probably the very specimen described by Linnæus. Sundevall (*Skand. Fiskar*, 1:st Edit., p. 160) included this fish under the name of *Labrus tessellatus*, Bloch, *Oecon. Naturgesch. Ausl. Fische*, Vol. VI, p. 8, plate CCXCI, fig. 1, which should thus be synonymous with *Labrus onitis*. As we now know that the younger specimens of *Tautoga onitis*, a species very common on the west coast of the United States, and which in a mutilated condition (without the anal fin) has been described by Linnæus (*Syst. Nat.*, ed. XII, p. 475) under the name *Labrus hiatula*, possess the network of coloured lines mentioned by Bloch (cf. Jordan and Gilbert, *Synopsis of the fishes of North America*, *Bull*, *U. S. Nat. Mus. N:o 16*, pp. 600 and 936), there is no doubt that Sundevall's opinion was correct. The colouring of the specimen described by Linnæus is, it is true, destroyed by the action of the alcohol in which it has been preserved, but there are still traces of dark markings which seem to have resembled those given in Bloch's figure; and when Sundevall described this specimen, some dark dots on the ventral side, mentioned in Linnæus's description, were especially distinct. The fish is 142 mm. in length. There are no scales on the operculum, except on the top margin; and the fin formula is $D.\ \frac{17}{10}$, $A.\ \frac{3}{8}$. The pectoral fins are fairly large, in length about $^{3}/_{4}$ of the greatest depth of the body, and there are 15 rays, the first of which is simple, and in addition to these one small ray at the beginning of the fin. The ventral fins are scarcely more than $^{2}/_{3}$ of the pectoral fins in length. The caudal fin has 13 branched rays of equal length, and one shorter simple ray with several $\left(\frac{4}{3}\right)$ supporting rays on each side. The jaw-teeth are set in two rows, the inner of which is indistinct and incomplete; the front teeth in the outer row are fairly large, and the two middle teeth in each jaw the largest of all, conical at the base, flat and truncate at the apex. There is no record of the place of origin of this specimen, but that it comes from America is a matter that scarcely admits of question, any more than we can doubt that it must have been at second-hand that Bloch got his specimen from Norway.

That the *Labrus ossifagus* of Linnæus ($D.\ ^{17}/_{14}$, $A.\ ^{3}/_{12}$; '*habitat in Europa*') belongs to this species, as both Valenciennes and Sundevall have assumed, is most highly probable, for no other European *Labrus* more nearly corresponds with Linnæus's description in the number of the fin rays. But, as Linnæus has left no specimen himself and has not cited any authority or figure, there still remains enough uncertainty to prevent the use of this name for the species. Linnæus has indeed confused the habitats in his *Systema Naturæ* so often that it is impossible to place implicit reliance in his statements. Thus in the *Mus. Ad. Frid.* p. 66, he assigns no region to *Sciæna* (*Labrus*, *Syst. Nat.*) *punctata*, which, to judge by the specimen in the Royal Museum, is the species that has subsequently been named *Polycentrus Schomburgkii*, by Müller and Troschel, or to *Sciæna* (*Labrus*, *Syst. Nat.*) *bimaculata*, which, to judge by the specimen in the Royal Museum, is the *Acara bimaculata* of later writers, and therefore, like the former species, undoubtedly comes from Guiana, though both of the above-mentioned specimens have no region assigned to them in the labels from Linnæus's time. In the *Systema Naturæ* the region of the former species has been given correctly ('Habitat Surinami'), but *Labrus bimaculatus* is said to inhabit the Mediterranean. In one of the earliest collections in the Royal Museum there is a specimen of *Labrus mixtus*, but it is only ticketed *Labrus*, without any Linnæan label or statement as to its habitat. This uncertainty compels us to retain for the Striped Wrasse the Linnæan name which has first been fixed with scientific accuracy. (Cf. Valenciennes, l. c.).

This fish generally attains a length of from 300 to 350 mm., but the female is apparently always a little smaller than the male and most probably does not exceed the former measurement. The length of the head, measured to the apex of the gill-cover, is about $^{1}/_{3}$ of the length of the body *minus* the caudal fin, which measures about $^{2}/_{3}$ of the length of the head. The body is more elongate than is the case with any other of the Scandinavian members of this genus, except the Scale-rayed Wrasse (*Labrus Palloni*); its greatest depth, which is almost uniform along the anterior half of the dorsal fin, is from $^{6}/_{25}$ to $^{2}/_{9}$ of the total length. Least depth of the body $^{1}/_{9}$ of the length[a]. The production of the snout is especially remarkable; it tapers regularly to a point, forming a rectilinear profile, and is so produced that it forms an angle of less than 60° when the jaws are closed. The distance from the eye to the tip of the snout is about equal to the depth of the head at the anterior orbital margin. Head slightly compressed and transversely rounded at the top. Body still more compressed, the thickness about $^{1}/_{2}$ of the depth.

The eye is closely surrounded by the tense, thin, dermal margin of the orbit; the diameter about $^{1}/_{3}$ of the distance from the tip of the snout. The pupil not quite circular but slightly produced anteriorly. The nostrils are very small, and remind one of the stitches in a piece of needlework; the two openings on each side are a good way apart from each other. The posterior opening is higher than the anterior corner of the eye and on a level with its anterior margin; the anterior opening lies at a point such that the distance to the eye is about $^{1}/_{5}$ of the distance to the tip of the snout, it is on a level with the articulation of the lower jaw and has a small tubular rim.

The mouth is larger than in the other Scandinavian wrasses. It extends half the distance between the eye and the tip of the snout, but the dermal folds reach a little further back. The jaws are of equal size. The lips are also fairly large. The upper lip in particular is considerably produced, and underneath thickly covered with small papillæ and closely folded, as is also the large bent lateral flap of the under lip. The teeth, as in the other species of this sub-family, are thick and conical, and are set in a simple row; the front teeth are the largest, they are curved and project slightly. In the lower jaw the middle pair are a little smaller than the teeth on each side of them, in the upper jaw they are the largest of all. On each side of the upper jaw 13, on each side of the lower jaw 16 teeth, at most; the 5 back teeth in both jaws fairly small. Within this row another irregular but simple and complete row of small but strong teeth which in the living fish are entirely hidden in the gums. The pharyngeals densely covered with cylindrical, straight and blunt teeth. No teeth on the vomer, the palatine bone or the tongue; and the folds of skin (*vela*) within the mouth, as in all Labri, of considerable size. The branchiostegal membrane, as in the other species, large; it encircles the throat with a broad, free margin and is furnished on each side with 5 slightly curved, fine rays. The gill-cover free up to the lateral line. The hind margin of the preoperculum generally without serration; but in some specimens, and especially in the females, it is finely denticulated, almost as in *Labrus rupestris*, etc., which CUVIER on this account referred to distinct genera.

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[a] In 6 measured specimens the least depth of the tail was on an average 10.9 % of the length of the body; the minimum was 10.5 %, the maximum 11.5 %.

The scales are large and almost rectangular, with their free edge somewhat rounded and the breadth about $^3/_4$ of the length, but they overlap each other to a great extent. Their central area is very large, occupying about half the length and breadth of the scale, and densely punctate. In the posterior part of the scale the striation is concentric with the margin, but laterally it is slightly oblique, and in the anterior part runs from the margin inwards. The longitudinal striation is visible only in the anterior part, the margin of which is deeply denticulated. In the transverse line from the lateral line to the dorsal fin there are 6 scales, and between the former and the ventral fins 19 or 20. The lateral line, which runs parallel to the dorsal line and follows the curve of the back, as in all the Scandinavian species of this genus, contains 46 or 47 scales furnished with a small duct curving slightly upwards. In the posterior part of the lateral line the scales are much more crowded than in the anterior part, and they advance over the caudal fin. The continuations of the lateral line on the head consist of very fine pores in the same position as in most other fishes. The vent is a little behind the middle point of the body below the 16th dorsal ray.

The dorsal fin commences just over the extremity of the gill-cover. It is of uniform height, with the first ray a little shorter and some of the hind ones slightly longer than the rest. The first 16, 17, or 18 hard, unarticulated and pungent, with a membranous flap (*ramentum*), as usual, behind the point; the others, from 11 to 13 in number, articulated, the first simple, the second and third divided, the others with a further division of their hind branch. The last is so deeply divided that one may easily take it for two rays. In both sexes the proportion of these rays is inconstant, being $\frac{18}{12 \text{ or } 13}$, $\frac{17}{13}$ or $\frac{16}{14}$, making 30 or 31 in all.

The anal fin is right opposite the posterior part of the dorsal, commencing at the 17th ray, and is of about the same depth and shape, but the spinous rays, which are 3 in number, gradually diminish in size towards the beginning of the fin. It has 11 soft rays, seldom 10 or 12, the first or both the first and second simple, the last, as usual, double. The length of the anal fin is considerably greater than in the preceding species; it is about $^1/_6$ of the length of the body[a].

The pectoral fins broad and short, about $^2/_5$ of the head in length, obtusely rounded, with 16 rays, seldom 17. The first ray comparatively short and simple, the second simple and a little shorter than the third, fourth and fifth which are divided; the rest are doubly and more deeply divided; the last gradually diminish in length.

The ventral fins are inserted a little behind the pectorals, commencing underneath them at about their middle point, and $^1/_8$ or $^1/_9$ as long again as they; they have, as usual, 6 rays, the first of which is hard and pungent and about $^2/_3$ of the fin in length; the others articulated and three times doubly divided; the third longest, the last almost as long as the first.

The caudal fin scaly at the base, short, the extremity straight with rounded corners. It has 11 rays of equal length, trebly and deeply divided, and on each side one somewhat shorter simple ray, together with 3 very short and indistinct supporting rays.

The internal organs resemble those of the preceding species. In the month of July SUNDEVALL found in the ovaries a large number of newly formed, small eggs. The peritoneum, as in the Ballan Wrasse, thin and whitish.

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[a] In 6 measured specimens the length of the base was on an average 17.3 % of the total length; the minimum was 15.6 %, the maximum 18.3 %.

The colouring of the Striped Wrasse differs considerably according to the sex, more so than is usual among fishes; but both male and female are among the most gorgeous of European fishes and are conspicuous even among the species of the wrasse family, distinguished as these species are by their universal beauty and brilliancy of colour.

The male is dark green, nearly black, with broad, curved, blue stripes on the head, and 5 irregular blue stripes along the body. The belly is flame-yellow, interspersed in the anterior part under the head with blue spots so dense that they sometimes run into each other. The fins flame-yellow with a narrow edge of blue. On the dorsal fin there is, in addition to this edge, a large patch of blue which extends over the greater part of its first half and is continued by a row of blue spots. The caudal and anal fins are marked with rows of blue spots, and the whole extremity of the ventral fins is blue. The colouring varies a little, as the extent of the dark and yellow tints, especially in the posterior part, is not always the same. In some instances the caudal fin is almost wholly blue spotted with yellow, in others, according to Valenciennes, the yellow colour spreads backwards along the dorsal sides. The situation of the blue markings is constant, but they may be more or less coalescent. The pectoral fins are generally dark green, but according to the figure given by Ascanius they may also be flame-yellow.

The female is minium-red all over, with the same blue marks on the head as the male, but they are more widely dispersed. On the posterior part of the back there are 3 large, black spots,[a] the first two of which are separated by a whitish patch, and situated at the base of the branched dorsal rays. These three spots are visible even in specimens which have long been kept in alcohol. The three vertical fins have narrow blue edges, and the beginning of the dorsal fin is always of a more or less pronounced shade of black, a slight trace of correspondence to the blue colouring of the male.

Among the males there is a further difference in colour, still more marked than that we have already mentioned: the younger males display a more or less close resemblance to the females on account of their comparative lightness of colour, at any rate until they have attained a length of from 150 to 170 mm. — A male 198 mm. in length, preserved in spirits, seems to have been very slightly dark with a very small blue patch on the dorsal fin. The blue stripes on the body appear only in the anterior part above the pectoral fins, and on the back are indistinct but unmistakable traces of the three black spots which occur in the female. The caudal and ventral fins resemble those of older males. — It is also said that the wrasses are subject to periodical changes of colour depending on the season of the year, and that in winter their colouring is duller.

In consequence of their remarkable difference in colour, both sexes were long described as distinct species, and were regarded as such by Valenciennes in 1839, in spite of the fact that by the *Fauna* of Retzius (1800) his attention was called to the opinion current among the Norwegian fishermen, first made known by Fabricius, that the two species represented only different sexes of the same species. The opinion of Fabricius himself was not published before 1818, and does not seem to have attracted the attention of anyone until it was brought to light by Krøyer. Before this time Fries and Wright, in the first edition of «Scandinavian Fishes,» had given an independent and complete solution of the whole question.

During his visit to Bohuslän Fries was enabled to examine several specimens of both these varieties, and in 1835 he first remarked that no females occurred of the blue variety, and no males of the red. Not being able to discover any difference in shape between them, he assumed that they belonged to the same species. This assumption was completely verified by the investigations made by v. Wright and him during a year's stay at the same place, when they were enabled to examine a large number of specimens of both varieties.

In the works of several authors we may find descriptions of male specimens of *Labrus carneus* or *trimaculatus*, which was the ordinary name for the female. This error may have arisen, partly from the fact that the colour of the specimens described had been destroyed by the spirits in which they were preserved or in the process of drying, and partly from the similarity mentioned above as existing between the females and the young males. It is also not unlikely that males may sometimes occur in which the dark colouring is never developed and which consequently always resemble the females. The fact that we have descriptions of blue females gives rise to the conjecture that in warmer climates the female occasionally acquires the colouring of the male, a phenomenon which has not however been observed on the coast of Sweden.

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[a] Day, *Fish. Gt Brit., Irel.*, I. p. 258. mentions a female with only one of these spots; Couch, *Fish. Brit. Isl.*, mentions (p. 37) several with four spots and gives a figure (Plate CXXXIII) of one of them.

The Striped Wrasse occurs on all the coasts of Europe, with the exception of the shores of the Arctic Ocean and the Baltic. In Norway it is still found in the neighbourhood of Trondhjem, but how far north it goes, is unknown. In Finnmarken neither this nor any other species of the genus *Labrus* occurs, according to the investigations made in that district by LOVÉN, SUNDEVALL, and others. On the Swedish coast it is found only in the island-belt of Bohuslän, where it is by no means a common species. In the Sound and within the Baltic there is no authenticated instance of its occurrence. In England and France, as well as in the whole of the Mediterranean, the species is by no means rare. In Iceland and Greenland it has not been found.

The Striped Wrasse, like the rest of the genus, is a true 'rockfish',[a] only living near rocky or steep and stony coasts. On low, shelving, sandy coasts it is apparently never found. But even in the island-belt this species seems to be confined to certain fixed localities. In the whole district of Lysekil it is said to be found only among the islands known as Flatholmarne, where, together with the four other species of Swedish wrasses, it seems to have its favourite haunt near a little rock called '*Snultreskär*' (Wrasse Rock). According to MALM it is most common in Bohuslän on the islets known as Väderöar and Koster.

In the summer the Striped Wrasse remains at a depth of from 5 to 10 fathoms among rocks and stones, but in winter it apparently moves to still greater depths. FRIES and v. WRIGHT at all events failed to obtain a single specimen during the cold season; and in YARRELL's book on the fishes of England the same statement is made. It lives on shellfish and all other kinds of marine animals, especially crayfish. In the stomach of a female 300 mm. in length, which was caught on Snultreskär, the islet we have just mentioned, and which SUNDEVALL had the opportunity of observing in the month of July during life, he afterwards found remnants of several different crustaceans and an almost entire *Portunus* one inch in breadth, together with the scales, fins and bones of some small fishes. This specimen had very small ovaries containing only small and newly formed eggs, from which he inferred that the ovaries had already discharged their contents and that the spawning season must be earlier than midsummer; but he failed to obtain any more exact information on this point. In Norway, on the other hand, KRØYER found the Striped Wrasse ready to spawn at the end of June or July; and RISSO says that in the Mediterranean it spawns twice a year. In England COUCH found females with the ova fully developed in April and May, and also in July and August.[b]

The flesh of the Striped Wrasse is firm and white and is said to be of tolerably good flavour, but like the other wrasses it is seldom eaten in Scandinavia. However, it takes a bait readily (cf. the remarks on the preceding species), and is occasionally caught in a net or seine, but on the Scandinavian coasts it is not sought after by the fishermen.

In Bohuslän as in Norway the male is called *Blåstål*, or rather *Blåstrål* (Blue-stripe), the female *Rödnäbba* (Red-beak). In Norway the male is said to be also called *Blåskal* and *Blåstak*. In STRÖM's description of Söndmöre the female is called *Bergnäbba* (Rock-beak), and in ASCANIUS *Sudernål*; NILSSON also gives the names *Rödsnäcka* (Red-shell) and *Sypiga* (Seamstress).

(SUNDEVALL, SMITT.)

THE SMALL-MOUTHED WRASSE OR ROCK COOK (SW. GRÄSSNULTRAN.)

LABRUS (CENTROLABRUS) EXOLETUS.

Plate 1, fig. 3.

Head naked above the eyes. Number of scales in the lateral line less than 40 (about 35). Not more than 4 rows of scales above the lateral line. Interoperculum half covered with scales, naked only at the margin and in the anterior part. Cheeks covered with large scales, with 4 suborbital rows. Number of spinous rays in the anal fin more than 3.

R. br. 5; *D.* $\frac{18-19}{7-6}$; *A.* $\frac{4-5}{7}$; *P.* $\frac{2}{12}$; *V.* $^{1}{}_{5}$; *C.* $x+11+x$; *L. lat.* 33—37.

Syn. *Labrus exoletus*, LINNÆUS, *Syst. Nat.*, ed. X, p. 287; NILSSON, *Prodr. Ichth. Sc.*, p. 77; FRIES et WRIGHT, *Skand. Fiskar*, ed. I, p. 48, tab. 9, fig. 2; CUV., VAL., (*Acantholabrus*), *Hist. Nat. Poiss.*, XIII, p. 247; NILSSON, *Skand. Fn. Fisk.*, p. 277; GÜNTHER, (*Centrolabrus*), *Brit. Mus. Cat. Fish.*, IV, p. 92; COLLETT, (*Acantholabrus*), Christ. Vid. Selsk. Forh. 1874, Tillægsh., p. 94; ID., ibid. 1879, n:r 1, p. 61; MALM

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[a] Sw. *skargardsfisk*. *Skärgård* is the Swedish name for the belt of small rocky islets which fringes the coasts of Norway, Bohuslän, Finland, etc. TR.

[b] DAY, l. c., p. 258.

(*Centrolabrus*) *Gbgs*, *Boh. Fn.*, p. 479; LILLJEBORG, *Sv.*, *Norg. Fiskar*, I, pag. 452.

Obs. NILSSON has given this species the name *Småmunt Snultra* (a translation of the Small-mouthed Wrasse (*Crenilabrus microstoma*) of THOMPSON and YARRELL), but we can find no sufficient reason for the rejection of the name which has formerly been given it in «Scandinavian Fishes.»

The greatest length that the Small-mouthed Wrasse seems to attain is about 150 mm., and it is generally from 100 to 125 mm. in length. We also infer that it does not attain a much larger size from the fact that in specimens only 100 mm. in length the generative organs are fully developed. In common with the Scale-rayed Wrasse it is distinguished from the other Scandinavian wrasses by the possession of 5 (sometimes 4) spinous rays in the anal fin, while the others as a rule have only 3. In its general shape too it has several peculiar and distinctive features, notably the strong compression of the body, the sharpness of the dorsal edge, the handsome elliptical shape of the body with the production of the snout, the small size of the mouth, the almost complete uniformity in depth of the dorsal and anal fins, both of which terminate in a somewhat sharp corner, and lastly the very slight increase in breadth towards the extremity of the caudal fin. The length of the head is a little under $^1/_4$ of the total length and much less than the greatest depth of the body. The jaw-teeth form a simple row and are comparatively small. The margin of the preoperculum is very clearly denticulated. In the lateral line there are from 35 to 37 scales with an entire posterior margin and pierced by a raised duct, the end of which is bent obliquely upwards. On the tail the ducts are almost confluent. The curve of the lateral line at the extremity of the dorsal fin is sharper than in the other Scandinavian wrasses. Above the lateral line there are 3 large rows of scales and one smaller row; below the line there are 10 rows. The scales are so thin that with a magnifying glass one can see the striate root of one scale through the scale overlapping it. The scales which cover the tail advance a little over the base of the caudal fin, but there are no rows of scales on the membrane between the rays of the fin. The dorsal fin consists of 18 or 19 hard, pungent rays with deeply indented membrane and membranous flaps at the tip, and not more than 6 or 7 soft rays divided at the point and with the membrane at the margin entire. It is orange in colour with a tinge of gray in the posterior part, and between the rays there are two rows of blue spots, the one at the base and the other halfway up. The membranous flaps and the extreme margin of the soft-rayed part are blue. The anal fin which is of almost the same shape, marking, and colour as the dorsal, consists either of 5 hard, pungent rays and 7 soft rays divided at the point and the last of them cloven to the base, or of only 4 spinous rays and 8 soft; in the latter case the first soft ray is not divided at the tip. The pectoral fins yellow, transparent and made up of 2 simple and 12 branched rays. The ventrals dirty-white and made up, as usual, of one spinous and 5 soft rays. The caudal fin gray with 13 yellowish brown rays (the uppermost and the lowest undivided) and two rows of blue spots on the fin-membrane; the extreme margin edged with blue.

The principal colour of the body is olive with a tinge of yellow at the sides and towards the belly a gloss of bright gamboge, which is peculiar to this species. The belly is dirty-white and is without spots. The edges of the scales, with the exception of those on the belly and head, are blue, darker at the top than at the bottom, and thus form crescent-shaped spots which greatly enhance the beauty of this little fish. The head is yellowish brown with the forehead of a darker shade and the gill-cover yellowish; along it there generally run 6 violet bands, like reins, in the direction shown in the figure. The iris is reddish brown with a narrow ring of lighter hue next the pupil, which is of a beautiful shifting green.

In its internal organs this species corresponds to the preceding one.

The Small-mouthed Wrasse seems to be exclusively an inhabitant of the northern seas. The statement that it is found in Greenland, however, is only based on a vague conjecture of FABRICIUS and, as far as we know, has not been confirmed in later times. In Scandinavia, at least in Sweden, it occurs more rarely than any other species of the wrasses. South of Bohuslän it has never yet been met with on the coasts of Scandinavia. Its mode of life resembles that of its kindred species, but it is more confined to the seaward side of the islets and has never been found far up the fjords; that is the case at least in the island-belt of Bohuslän. In the places they frequent they are found in small companies.

To the fisherman this little species is of no especial value.

(FRIES, SMITT.)

JAGO'S GOLDSINNY (SW. STENSNULTRAN).

LABRUS (CTENOLABRUS) RUPESTRIS.

Plate 1, fig. 2.

Top of the head naked. Number of scales in the lateral line less than 40.[a] *Above the lateral line not more than 4 rows of scales. Interoperculum upwards scaly for the greater part of its length. Cheeks covered with large scales; 4 or 5 suborbital rows. Number of spinous rays in the anal fin 3. The anal fin so short that the least depth of the tail is at least 85 per cent of the base of this fin.*[b]

$R.\,br.\ 5;\ D.\ \frac{17-18}{2+7\ 1.\ 6};\ A^{c}.\ \frac{3}{1+7};\ P.\ \frac{2}{12};\ V.\ \frac{1}{5};\ C.\ x+11+x;$

L. lat. 36—38.

Syn. *Sciœna rupestris*, LINNÆUS, *Mus. Ad. Fr.*, I, p. 65, tab. XXXI, fig. 7; ID. (*Labrus*), *Syst. Nat.*, ed. X. p. 286; RETZIUS, (*Perca*), *Fn. Suec. Lin.*, p. 337; CUVIER (*Crenilabrus*), *R. Anim.*, ed. 2, p. 259; NILSSON (*Labrus, Crenilabrus*), *Prodr. Ichth. Scand.*, p. 76; FRIES et WRIGHT, *Scand. Fiskar*, ed. 1, p. 45, tab. 9, fig. 1; CUV., VAL. (*Ctenolabrus*), *Hist. Nat. Poiss.*, XIII, p. 223; KRØYER (*Crenilabrus*), *Danm. Fiske*, I, p. 541; NILSSON (*Labrus, Ctenolabrus*), *Skand. Fn.*, *Fisk.*, p.274; GÜNTHER (*Ctenolabrus*), *Cat. Brit. Mus.*, *Fish.*, IV, p. 89; COLLETT, Christ. Vid. Selsk. Forh. 1874, Tillægsh., p. 92; WINTHER, *Prodr. Ichth. Dan. mar.*, Naturh. Tidskr., ser. III, vol. XII, pag. 26; DAY, *Fish. G:t Brit.*, *Irel.*, I, p. 264, tab. LXXIV; LILLJEBORG (*Labrus, Ctenolabrus*), *Sv., Norg. Fiskar*, I, pag. 442.

Labrus suillus, LINNÆUS, *Syst. Nat.*, ed. X, p. 285 (*ex It. Wgot.* p. 179 — Bärgsnultra); MALM (*Ctenolabrus*), *Gbgs, Boh. Fn.*, p. 478.

Obs. In his Journey through West-Gothland LINNÆUS described this species for the first time, though under the incorrect provincial name *Bärgsnultra*, the Bergsnultra of Bohuslän being really the species we have above termed Berggylta. This species on the contrary is clearly distinguished from the others by the fishermen of the district under a special name (vid. MALM, l. c.) which is too obscene to be quoted, much less retained here. In the tenth edition of his *Systema Naturæ* LINNÆUS gave this same species the name *Labrus suillus*; but owing to a misprint in the 'Journey through West-Gothland' the mistake has arisen that in the description we have »spinis dorsalibus 9» instead of 19. This circumstance has made it more difficult to recognize *Labrus suillus*, and has misled LINNÆUS himself. In *Mus. Ad. Frid.* he again described this species under the name *Sciaena rupestris*, and in the tenth edition of *Syst. Nat.* he gives both as distinct species of the genus *Labrus*, without being able to assign any habitat to the species he describes under the latter name. Again, as STRÖM in his 'Description of Söndmöre' (I, p. 292) referred to LINNÆUS'S *Labrus rupestris*, this fish too might have been given as a Scandinavian species in the twelfth edition of Syst. Nat. As *suillus* is a later name for the species than *rupestris*, it is more strictly correct to use the latter. In *Zoolog. Danica* (Tab. 107, Tom. 3, p. 44) ABILDGAARD erroneously included this species under the genus *Perca*. This is the reason why RETZIUS in *Fn. Suec.* quotes the species *Labrus suillus* from LINNÆUS and *Perca rupestris* from ABILDGAARD, though he suspected that they were identically the same.

The Goldsinny is one of the smallest of the Scandinavian wrasses. The largest specimens we have seen measured 170 mm., and the average length is about 120 mm. The form of the body most resembles that of the Scale-rayed or the Ballan Wrasse. The shortness of the anal fin reminds us especially of the latter. The length of the head is about $^1/_4$ of the total length and is about the same as the greatest depth of the body, except of course in the case of females full of roe. The lips are shorter than in the Ballan Wrasse and not so broad; the upper lip is the thicker and presents a truncate appearance, in consequence of which the lower part of the upper jaw-bone is clearly visible and the corners of the mouth are less distinct. The teeth in both jaws are set in a somewhat narrow outer row and one or more less regular inner rows, sometimes roughly resembling the arrangement given in the figure of the Scale-rayed Wrasse. The teeth in the outer row large and subulate with the points bent inwards, the front ones largest; the inner teeth smaller but projecting distinctly above the gum. The eyes of middling size, their longitudinal diameter close upon $^1/_4$ of the length of the head, and in younger specimens equal to the breadth of the forehead, in older ones $^2/_3$ of that breadth. They are so situated that the line from the snout to the middle point of the caudal fin touches the lower edge of the pupil. The superior part of the interoperculum is almost entirely covered with scales. The hind margin of the preoperculum is finely serrated. During life however these serrations are not very distinct, as long as the bone retains its covering of skin; but if this be removed, or if the fish be immersed in alcohol or dried for some time, they become distinctly visible.

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[a] Forty at most, according to GÜNTHER.

[b] The least depth of the body in proportion to the base of the anal fin increases with age. In 6 measured specimens the least depth of the tail was on an average 93.3 % of the base of the anal fin; the minimum was 85.7 %, the maximum 100 %.

[c] Occasionally only $\frac{3}{1+6}$, as in the type-specimen of LINNÆUS's description of the species in *Mus. Ad. Frid.*

The lateral line runs much nearer the back than the belly and contains from 36 to 38 scales, which are smaller than those of the nearest rows and have the hind margin notched obliquely upwards so that the lower corner is longer than the upper. Above the lateral line there are three rows of ordinary scales, four rows in all, including the row of smaller scales at the base of the fin. Below the lateral line from 10 to 12 rows.

In the dorsal fin there are 17 hard and pungent rays and 9 soft and articulated, or 18 hard and 8 soft, the last ray being split to the base. As a rule, the first two soft rays are, on the contrary, undivided. The anal fin, the posterior corner of which is somewhat pointed, has the membrane incised and a flap behind each spinous ray, as usual: it consists of 3 hard rays and 8 or sometimes 7 articulated soft rays, all except the first branched at the tip. The pectoral fins are very thin and transparent. They are made up of 14 rays, the first being short and hard, the second simple and the others branched at the tip. The caudal fin has the corners rounded and the hind margin also slightly rounded: it consists of 13 true rays, the highest and lowest of which are simple at the point and shorter than the others which are split. At the base of the fin there are the usual rows of scales between the rays.

In brilliancy of colouring the Goldsinny is far inferior to its kindred species, but still not without beauty. The upper part of the body is of an almost unvaried brown, the sides greenish with marks or spots at the base of each scale forming broken, longitudinal bands. On the sides of the belly, in the third or fourth row of scales below the lateral line, these spots become rusty yellow. The belly is bluish white without spots. A dark brown band, interrupted by the lower margin of the iris, runs from the upper lip to the margin of the preoperculum. This band is coasted above by another of pale green, which stops at the anterior orbital margin. The iris is of a dark reddish brown, with a ring of lighter colour at both the inner and the outer margin, and a bright green spot in the superior part.

Most characteristic of this species, however, is the uniform colour of the fins, which are without any spots or bands, if we except the anterior part of the dorsal, where the fin membrane between the first four or five rays is of a deep black half-way up, and from the fourth to the seventh has some bluish green streaks at the base. The Goldsinny is also sufficiently easy to recognize in most cases by the round black spot at the superior margin of the base of the caudal fin, which is always present except in the youngest specimens (up to a length of about 40 mm.[a]). The latter have instead a brown spot at the top and bottom of the base of the caudal fin.

From the remarks already made with regard to the variations of colouring in fishes we may conjecture, and rightly too, that the Goldsinny does not always correspond to the description given above. The specimen represented in the figure is one of the finest in colouring we have ever met with. As a rule the coloration is duller and fainter, and the shades of colour are more numerous. However, as this species is unmistakably distinct from the others, we should be unnecessarily diffuse, were we to give a more detailed description of these variations, especially as none of them is remarkable or preponderant. Before leaving this point, however, we must point out a remarkable change of colour which the Goldsinny can effect in a moment. When the fish is at liberty, it has 14 dark spots on the sides, obliquely crossing the lateral line so that there are 7 above and 7 below. These spots disappear instantly when the fish is touched and do not re-appear until it has been let alone for some time. Many other proofs have been given of the power which fishes possess to change their colour at will; but a more striking example than this, which was discovered by FRIES fifty years ago, can scarcely be adduced even at the present time.

In its internal structure the Goldsinny most closely resembles the Ballan Wrasse.

Of all the European wrasses the Goldsinny is the most common and most widely spread species. It is found from the coast of Pomerania in the Baltic[b] along Denmark and up the west coast of Scandinavia as far as Trondhjem[c] at least. To the south it occurs off the whole west coast of Europe and in the Mediterranean, in the inner part of which it is said to be less common. In Bohuslän during the summer it stays close to jetties and steep rocky shores where the water is only a fathom or so deep. At such spots it may be seen in small bodies seeking its food a little way from the bottom among the seaweed which grows so luxuriantly here. Its food seems to consist exclusively of the smaller species of crustaceans, worms, mollusks, etc., fragments of which are found in its stomach. It rises to the surface only when attracted thither by some prey, and as soon as this is caught, it again descends to the bottom. At the approach of danger it takes refuge under the jetty, in a cleft of the rock, or under some coarse-leaved seaweed. In the winter it withdraws into deeper water; at any rate it does not occur near shore at this time of year. It cannot, however, be very far away, for on the 12th January, 1838, v. WRIGHT found 5 specimens in the gullet and stomach of *Larus glaucus.* In Sweden it begins to spawn in the middle of June, at which time FRIES found this species in Bohuslän ready to spawn, or later. In the middle of July SUNDEVALL has found newly-formed eggs in the ovaries. There is evidence that in other countries it spawns in April and May[a] as well as in July[b]. Females with running roe occur of a length as small as only 86 mm. According to FRIES, the ovaries resemble those of the Striped Wrasse, but according to SUNDEVALL's description, they are posteriorly united into one. The roe is very fine (i. e. the eggs numerous) and yellowish, but quite transparent at the time of depositing.

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[a] Vid. MALM, l. c.

[b] Cf. MÖBIUS and HEINCKE, *Fische der Ostsee*, p. 72.

[c] Cf. COLLETT, l. c. and STORM, Norsk. Vid. Selsk. Skr. Trondhj. 1883, p. 28.

Where there is opportunity for other more remunerative fishing, the Goldsinny is held in no very high esteem. Still its flesh is white and firm, and would make a dainty dish if one availed oneself of it. It is often caught in large quantities in nets cast for other fishes. From the pier-heads in Bohuslän it may easily be taken with a small hook and a bait of periwinkle.

(FRIES, SMITT.)

THE GILT-HEAD OR CONNOR (SW. SKÄRSNULTRAN OR SKOTTAN).

LABRUS (CRENILABRUS) MELOPS.

Plate II, fig. 3.

Back of the head naked. Number of scales in the lateral line less than 40. Above the lateral line 4 (sometimes 5) rows of scales. Superior part of the interoperculum for the most part scaly. Cheeks with large scales in 5 suborbital rows. Number of spinous rays in the anal fin 3. Anal fin comparatively long, the least depth of the tail measuring at most $^{3}/_{4}$ *of its base*[c].

$R.\ br.\ 5;\ D^{d}.\ \frac{16}{9};\ A^{e}.\ \frac{3}{1+8};\ P^{f}.\ {}^{2}/_{13};\ V.\ {}^{1}/_{5};\ C.\ x+11+x;$
$L.\ Lat.\ 34^{g}.$

Syn. *Labrus melops*, LINNÆUS, *Syst. Nat.*, ed. X, p. 286; CUV. VAL., (*Crenilabrus*), *Hist. Nat. Poiss.*, XIII, p. 167; KRØYER, *Danm. Fiske*, I, p. 521; SUNDEVALL, (*Labrus*) *Skand. Fiskar*, ed. I, p. 182; NILSSON, (*Labrus, Crenilabrus*), *Skand. Fn., Fisk.*, p. 270; GÜNTHER, (*Crenilabrus*), *Brit. Mus. Cat., Fish.*, IV, p. 80; MALM, *Gbgs, Boh. Fn.*, p. 477; DAY, *Fish. G:t Brit., Irel.*, I, p. 260; MÖB., HCKE. *Fische der Ostsee*, p. 70; COLLETT, *N. Mag. f. Naturv.*, B:d 29 (1884), p. 73; LILLJEBORG (*Labrus, Crenilabrus*), *Sv., Norg. Fiskar*, p. 436.

Lutjanus norwegicus, BLOCH, *Naturg. Ausl. Fische*, V, p. 11, tab. CCLVI; NILSSON (*Labrus*), *Prodr. Ichth. Scand.*, p. 76; FRIES et WRIGHT, *Skand. Fiskar*, ed. I, tab. 44; CUV., VAL. (*Crenilabrus*), l. c. p. 176.

Perca maculosa, RETZIUS, *Fn. Suec. Lin.*, p. 337.

Labrus Rone, ASCANIUS, *Ic. rer. nat.*, II, p. 6, tab. XIV; NILSSON *Prodr.*, p. 77; CUV., VAL., l. c., p. 172.

Labrus tinca, TURTON (YARRELL); *Labrus turdus*, MÜLLER, *Crenilabrus Pennantii*, CUV., VAL., *Labrus cornubicus*, GMELIN (YARRELL); *Crenilabrus Donovani*, CUV., VAL.; *Crenilabrus Couchii*, CUV., VAL.; *Labrus gibbus* (PENNANT) GMELIN (CUV., VAL.): vide GÜNTHER et DAY, ll. cc.

Note. VALENCIENNES was the first to state that the fish which LINNÆUS had described as a Mediterranean species under the name *Labrus melops*, also occured in the North Sea and off the coast of Denmark. But KRØYER was the first to prove that this same fish had long been known to the Scandinavian faunists and described by them as a Scandinavian species. Thus he was able to prove that all the names given above really belong to one single species. SUNDEVALL gave the additional information that the type-specimen of LINNÆUS's

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[a] Vid. DAY l. c., p. 265.

[b] Vid. KRØYER l. c., p. 555.

[c] In 5 measured specimens the least depth of the body was on an average 68.5 % of the base of the anal fin, the minimum being 63.5 %; the maximum 74.2 %.

[d] Sometimes $\frac{15}{9}$ or $\frac{16}{1+8}$. According to DAY $\frac{14-17}{8-9}$ (l. c. p. 262).

[e] Sometimes $\frac{3}{10}$ or $\frac{3}{2+7}$ or $\frac{3}{1+9}$.

[f] Sometimes 2 + 12, sometimes 2 + 12 on one side of the body and 2 + 13 on the other.

[g] 32—35 according to DAY. l. c.

Labrus melops, with one old manuscript label and another printed one, »*Labrus melops*«, still exists in the Royal Museum of Stockholm, where it has been brought together with the rest of the old Drottningholm collections described by Linnæus in *Mus. Regis et Reginæ*. He states further that it exactly corresponds to the northern *Labrus norvegicus* and *Labrus rone*, and has, like them, only 5 branchiostegal rays, though Linnæus has given 6 in his description of the species in *Mus. Ad. Fr.*, as well as in the generic characters in *Syst. Nat.* (following Artedi).

Adult specimens of this fish are about 210 mm. in length. The body is deeper than in the other Scandinavian wrasses. The greatest depth, which is the line from the base of the ventral to the beginning of the dorsal fin, is a little less than $^{1}/_{3}$ of the length of the body — in the adult it is $^{1}/_{3}$ of the distance from the tip of the snout to a point in the caudal fin $^{1}/_{3}$ of the distance along it. The length of the head is from $^{3}/_{10}$ to $^{4}/_{13}$ of the length of the body, in younger specimens a little greater in proportion. It is deep and short, the superior and inferior profiles being almost perpendicular to each other, when the mouth is closed. The mouth, when closed, is obliquely rounded and turned slightly upwards, as the inferior profile of the head rises more sharply than the superior profile slopes. The eye is small, and, as in the Ballan Wrasse, its inferior margin is considerably above the median line of the body. Its distance from the tip of the snout, when the mouth is closed, is from $\frac{5}{3}$ to $\frac{5}{2}$ of its diameter. The nostrils are placed as in the other wrasses. As we have just mentioned, the mouth is placed high up, and it is smaller than in the rest of the Scandinavian wrasses, except the Small-mouthed Wrasse, for it does not extend to the middle point between the eye and the snout. The lips are thick but comparatively short, and the jaws equal in length. The teeth are conical, obtuse, strong and set close together; there are 5 or 6 on each side in the upper jaw and about 8 in the lower. As usual the teeth diminish in size as they recede; the middle pair, which in the upper jaw are a little apart, are in both jaws the largest. The preopercular margin is more sharply denticulated than in the other Scandinavian wrasses, and has about 50 small serrations.

The scales are large and square or almost pentagonal, with rounded corners. When they are pentagonal, the fifth side is formed by the free posterior edge, which is sharply rounded. The lateral line, which is parallel to the dorsal line and bends sharply at the end of the dorsal fin, contains about 34 scales (36 or 37 if we include the scales above the gill-cover). Above the lateral line there are 4 rows of scales, below it 10 or 11. The vent is about half-way between the tip of the snout and the end of the tail, i. e., a little in front of or behind the middle point, under the 12th or 13th dorsal spine.

The fins are of the same structure as in the species already described. The dorsal fin commences right over the posterior edge of the gill-cover, and its length is equal to $^{1}/_{2}$ the length of the body *minus* the caudal fin. It has 25 rays, 16 of which are hard and somewhat pungent, and 9 branched, seldom $\frac{15}{9}$ or $\frac{16}{8}$; the first soft ray is sometimes undivided. The first spinous ray is, as a rule, hardly $^{2}/_{3}$ of the third or fourth in length, while the second is only a little shorter than they. The anal fin is a little deeper posteriorly than the corresponding part of the dorsal fin. It contains 3 spinous rays, the first of which is a little more than half as long as the third, and 10 or sometimes 9 soft rays, the first of which is generally (the second sometimes) undivided or at any rate branched only at the extreme tip. The caudal fin is rounded, short, not quite $^{1}/_{6}$ of the total length, and scaly at the base. It admits of only slight expansion, as is the case throughout the genus. There are 11 perfect rays which are branched several times, 6 above the lateral line and 5 below it; and also, at the upper and lower margins, one simple and somewhat shorter ray, and 3 or 4 small, rudimentary (supporting) rays. The pectoral fin is inserted below the second ray of the dorsal fin; it is flatly rounded, is a little more than $^{1}/_{6}$ of the total length, and contains 15 (sometimes 14) rays, the first of which is very short (at most $^{1}/_{2}$, generally less than $^{1}/_{3}$ of the length of the fin) and simple, but soft and closely united to the second, which is also unbranched; the 4th, 5th, and 6th are the longest. The ventral fin is oblong, commences just behind the base of the pectoral fin, and is $^{3}/_{4}$ of that fin in length. It contains, as usual, 6 rays, the 3d and 4th of which are the longest, the 1st being spinous and not quite $^{2}/_{3}$ of the 3rd in length.

The colouring, as in all the species of the genus, is handsome but variable. The body of the Gilt-head, immediately after its capture, is greenish, blue on the back and with the edges of the scales throughout yellowish. The head is yellowish with crooked, green lines, and between the latter, at the posterior orbital margin, is an almost black spot. The fins are spotted with yellow, green and blue, but are without any distinct black spots. On the sides, below the lateral line, are several large, dark spots, transversely situated, the last of which lies near the caudal fin and is generally the darkest. — These markings disappear very soon after death, if the fish be preserved in weak alcohol, the whole body assuming an almost uniform grayish colour. But the blackish spot behind the eye always remains and becomes more distinct and even apparently larger than in living specimens. As a rule too, but not always, a slight trace remains of the dark spot by the caudal fin.

In Bohuslän the Gilt-head is not so common as the preceding species, though, according to MALM, more so than the Ballan Wrasse. To judge by the fact that it occurs more frequently on the Danish coast, this fish, as well as the Goldsinny, seems to thrive equally well off shores where the bottom is loose and rocky coasts, provided that the algæ are not too scanty. RETZIUS says that the Gilt-head is found off the North of Scania. According to NILSSON, KRØYER, and WINTHER it is common in the southern part of the Cattegat and in the Sound, as far as Kjøge. TRYBOM[a] states that it is caught together with the Goldsinny in the northern part of Öresund, where it is used as bait, chiefly for cod-fishing. According to MÖBIUS and HEINCKE it occurs, though seldom, at Kiel. Farther up the Baltic it has not been observed. Off Norway it goes, according to COLLETT and STORM, at least as far as the Fjord of Trondhjem. It also occurs along the whole west coast of Europe, off the shores of England and Ireland, and also in the Mediterranean. No Icelandic species of *Labrus* is known to us.

The food of the Gilt-head consists of crayfish, mollusks, etc. In its stomach LILLJEBORG has found fragments of *Carcinus mœnas*, *Littorina*, and *Mytilus*.

The spawning season, according to KRØYER, occurs in July. This same author relates, as observed by him, a circumstance which seems to show that a true pairing occurs in this species and that during that season the fish keep in pairs. He says that two specimens had been seen repeatedly, during an observation of some length, darting out of the seaweed by a jetty, pursuing each other, then suddenly turning the ventral sides towards each other and remaining for a while in this position. They then separated and again hid themselves in the seaweed, but only to reappear again after a short time and repeat these actions. A blackish papilla just behind the vent, which is perforated at the point and several times larger in the female than in the male, is thought to have served on this occasion as the organ of copulation, and a true penetration is supposed thus to have occurred. (SUNDEVALL, SMITT.)

SUBFAMILY **JULIDINÆ.**

To the brief diagnosis given above (p. 4) after GÜNTHER[b], we may here add that the *Julidinæ* are by no means inferior to the true wrasses in brilliancy of colouring, but rather surpass them, and are also far richer in variety of form. In the Atlantic, however, they are comparatively rare, though some species are represented in the West Indies and also occur in the Mediterranean. One of these Mediterranean fishes, *Coris julis*, has also spread into the Atlantic, but is rare even off the coasts of France and England. On two occasions, however, it has wandered into Scandinavian waters.

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[a] Gt. Internat. Fisheries Exhib., London 1883, Special Catalogue for Sweden, p. 132.

[b] *Brit. Mus. Cat., Fish.*, IV, pag. 66.

GENUS CORIS[a].

Head naked, fairly pointed. Body oblong, compressed, with comparatively small scales. More than 50 scales in the lateral line, which is unbroken. Spinous rays in the dorsal fin 9, branchiostegals 6.

THE RAINBOW WRASSE.

CORIS JULIS.

Fig. 2.

Length of the head from 25 to 28 per cent, greatest depth of the body from 17 to 20 per cent of the length of the body. Number of scales in the lateral line about 75. Above and below the lateral line, at its straight part at the beginning of the tail, 8 rows of scales. A dark-blue spot on the flap of the gill cover.

♂: *The first spinous rays in the dorsal fin are elongated, being the longest in the whole fin, and, between the first and the third or fourth ray, the fin-membrane is marked with a black spot.* ♀: *The length of the spinous rays in the anterior part of the dorsal fin increases as they advance along the fin, the first ray is the shortest, and in this sex there is no black spot developed on the fin-membrane.*

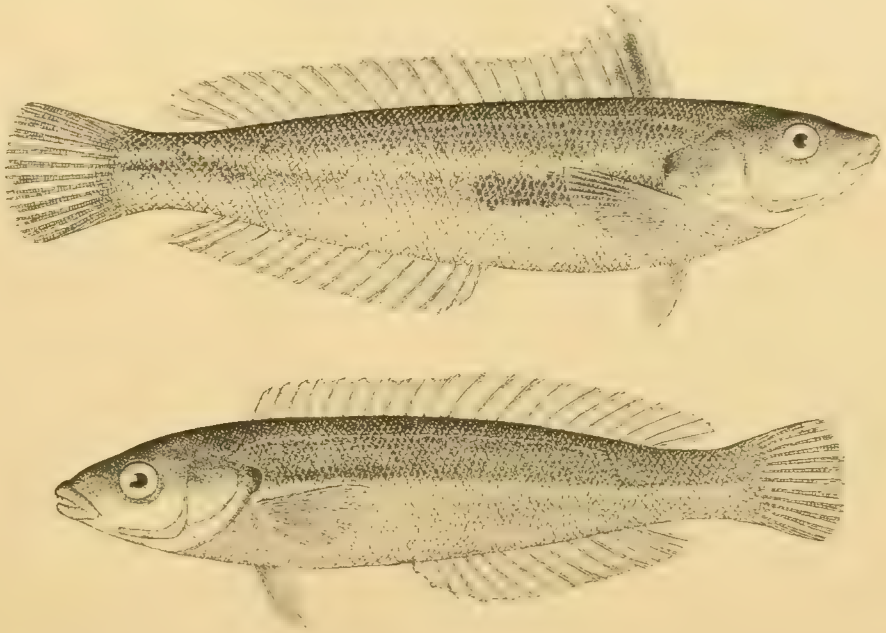

Fig. 2. The Rainbow Wrasse (*Coris julis*). ♂ and ♀. Natural size. Two of the type specimens of *Labrus paroticus* of LINNÆUS.

$R.\ br.\ 6;\ D.\ \frac{9}{12};\ A.\ \frac{3}{12};\ P.\ ^{1}{}_{12};\ V.\ ^{1}{}_{5};\ C.^{b}\ x + 12 + x;$

$L.\ lat.\ 73—75^{c};\ L.\ tr.\ abd.\ \frac{4}{20—25};\ L.\ tr.\ caud.\ \frac{8}{8}.$

Syn. *Labrus* palmaris varius, dentibus 2 majoribus maxillæ superioris, ARTEDI, *Ichth.*, *Gen.*, p. 34; *Syn.*, p. 53.

Labrus Julis, LINNÆUS, *Syst. Nat.*, ed. X, Tom. I, p. 284; GÜNTHER (*Coris*) *Brit. Mus. Cat.*, *Fish.*, IV, p. 195; DAY, *Fish. G:t Brit.*, *Irel.*, I, p. 269, tab. LXXVII; WINTHER, *Prodr. Ichth. Dan. mar.*, Naturh. Tidskr., ser. 3, vol. XII p. 27.

Labrus paroticus, LINNÆUS, l. c.

Julis mediterranea, *speciosa*, *Giofredi*, RISSO; vide GÜNTHER et DAY, ll. cc.

Julis vulgaris, FLEMING, *Brit. An.*, p. 210; CUV., VAL., *Hist. Nat. Poiss.*, XIII, p. 361; KRØYER, *Danm. Fiske*, I, p. 561.

Julis festiva, CUV., VAL.,; *Julis melanura*, LOWE; vide GÜNTHER et DAY, ll. cc.

Obs. Both in *Systema Naturæ* (10th and 12th Edd.) and in *Museum Adolphi Friderici* (*Prodr. tomi secundi*, pp. 75 and 76). LINNÆUS has described *Labrus Julis* and *Labrus paroticus*, the one after the other. In *Syst. Nat.* the Mediterranean is given as the habitat of the former, and India as that of the latter; but in *Mus. Ad. Frid.* America is given as the habitat of both. *L. paroticus* seems, however, to have disappeared from the system at a later time and has really no place there, save as a synonym for *Coris Julis*. In the Royal Museum are preserved in alcohol the 5 Linnæan type specimens of *L. paroticus*, which originally belonged to the Drottningholm Museum; and of these specimens we have procured drawings of one ♂ and one ♀.

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[a] GÜNTHER. l. c. p. 195. Cf. BLEEKER, *Atl. Ichth.*, I. pp. 55, 83, and 99.

[b] Of 9 specimens in the Royal Museum one has *C.* $x + 11 + x$.

[c] 75—80, according to GÜNTHER and DAY.

A comparison between the Rainbow Wrasse and the other Scandinavian wrasses at once suggests the relationship between the Perciform and Sciæniform fishes, according to Günther's definition of these groups, or between the *Scorpænina* and *Cottina* of the same author. Thus in the Rainbow Wrasse and the group which it represents (Julidinæ), the spinous-rayed part of the dorsal fin is less than the soft-rayed part, and the spinous rays are considerably weaker than in the true wrasses. Bleeker[a] gives as a character of the group *Pseudolabriformes*, which should correspond in the most important respects to Günther's *Julidina*, that the membranous flaps behind the points of the spinous rays are wanting in these fishes. But in fact they are present, at least in the Rainbow Wrasse — a point which Steindachner[b] and Day have shown in their figures — though they are small and most nearly resemble a bar-like thickening of the margin of the fin-membrane. Thus in this respect too, the Rainbow Wrasse is a typical member of the genus; but it has quite a different appearance from the wrasses, partly because of the elongated form of the body, and partly because of its naked head. In size it may attain a length of 250 mm. In younger and in average-sized specimens, the head forms $^1/_4$ or a little more of the length[c]; in older specimens, on the contrary, to judge by a stuffed male from the Mediterranean, 250 mm. in length, the proportional length of the head may apparently sink to $23^1/_2$ % of the length of the body. The least depth of the body and its greatest thickness are about equal to, or less than half the greatest depth. According to Day's explanation (l. c.) of the difference between the sexes, which had previously been regarded as a difference of species — *Coris Julis* = ♂, *Coris Giofredi* = ♀ — the shape of the dorsal fin varies considerably, but only in its anterior part. In the male it is considerably raised, the first spinous rays being in length about three times the distance of the lateral line from the dorsal profile, and in a high degree adds to the distinctive appearance of the fish, on account of the black spot on the fin-membrane. In the female this spot is entirely absent, but in both sexes the length of the posterior dorsal spines is less than the depth of the soft-rayed part of the fin. The anal fin, with its three spinous rays gradually increasing in length, the first being extremely small, and the first soft ray sometimes undivided and usually branched but slightly at the point, in other respects, both in shape and position, fully corresponds to the soft-rayed part of the dorsal fin. The caudal fin, which is rounded at the posterior margin, formed an exception, in all the specimens I have examined except one, to the rule among the generality of wrasses, in the fact that the number of the branched rays was 12 instead of 11. The ventral fins are shorter than the pectoral, being about $^2/_5$ of the head in length, while the length of the pectoral fins is about $^1/_2$ of the length of the head. The dental equipment is fairly powerful; there are about 11 teeth on either side of each jaw in the outer row, the front ones being the largest, the most pointed and the most crooked, and within this row there is another row of blunt teeth. At the corners of the mouth, on the posterior end of the intermaxillaries, there are one or two large teeth projecting forward. Both the nostrils on each side are small, the anterior being about as far distant from the posterior as the latter from the anterior supra-orbital corner. The longitudinal diameter of the eyes in average-sized specimens is about $^2/_5$ of the breadth of the forehead between the eyes. The interopercula and subopercula are fairly broad, on account of their dermal expansion, the former meeting each other beneaht the head. As a rule too they cover the branchial membrane attached to their inner side, together with the 6 branchiostegal rays, which are visible, however, through the thin membranous margin, which is continued superiorly by the coloured flap of the operculum. The lateral line follows the dorsal edge, at a distance of only 4 or sometimes 3 rows of scales from it; but at the 10th soft ray in the dorsal fin (the 19th ray, counting from the commencement of the fin) or in a line with the space between the 9th and 10th, it suddenly bends downwards to the middle of the side of the tail, so suddenly that it resumes its straight course in a line with the 11th soft ray or the space between that and the 10th. In an oblique transverse row, reckoning upwards or downwards in a posterior direction from the first scale in this straight part of the lateral line, there are 8 scales.

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[a] *Atl. Ichth.*, *Labr.*, p. 55.

[b] *Ichth. Span. Port.*, Sitzber. Akad. Wiss. Wien, Abth. 1, Bd. LVII (1868), p. 701, plate III, fig. 2 and 3.

[c] In 5 measured specimens, the smallest 104 mm. long, the largest 168 mm., the length of the head varied between 25,2 % and 28,2 % of the length of the body.

The beautiful but changeable colouring of this fish, of which LINNÆUS said, 'formosissimus piscis Europæorum ob colores varios', has naturally disappeared in the specimens preserved in spirits which have been accessible to me; but the limits of the extension of the different colours may still be traced in the specimens a century old, the mementoes of LINNÆUS's studies, and are given in our figure. According to DAY, «the *males* are purplish or bluish-brown along the upper half of the body, and silvery-white below; along the upper half runs a broad and generally indented, yellowish-white line which commences behind the eye and is continued to the base of the caudal fin. A small, round black spot on the end of the opercle. Dorsal fin yellowish, with a purple or orange outer edge, while a purplish or greenish-yellow spot with a curved upper edge is present between each ray. A large oval, black or bluish spot exists on the anterior portion of this fin between the first and fourth spines. A black spot in the axil of the pectoral fin[a]. The anal fin is similar to the soft dorsal but lighter. In the *females* the upper third of the body is purplish, with a light yellow band passing from the eye to the base of the caudal fin: lower two-thirds of the body silvery with one or more yellow longitudinal bands. A dark spot in the axil of the pectoral fin, and another on the end of the opercle as in the male. The fins in the female reddish.»

As we have mentioned, the Rainbow Wrasse has only twice been met with on the Scandinavian coast; but these finds were made a good distance within the limits of our Fauna. In 1834 two specimens were caught in the Little Belt off Strib (Funen), which were forwarded to KRØYER and described by him. On another occasion, according to TAUBER[b], a couple of specimens were taken in the Sound, near Hellebæk.

In the Mediterranean the Rainbow Wrasse is among the most common of fishes[c]. Its flesh is white, of good flavour and easy of digestion. Its voracity is attested by tales in the literature of olden times, and it is even said to have attacked persons bathing.

In the following Acanthopterygian Eleutherognates, which we may call *Acanthopterygii lysipharyngei*[d], in order to distinguish them from the preceding division, the lower pharyngeals are, with few exceptions, free from each other. This division of the Acanthopterygians contains the most numerous and in general the most regular forms of Physoclysts, but many of the fishes which on account of their characters must be referred to this division, are, however, of an anomalous, even monstrous appearance in comparison with the typical piscine forms. All attempts to arrange the *Lysipharyngei* in natural, distinct groups, have met with great difficulties, for the character which distinguishes them from the preceding division is by no means universal (though this does not affect the Scandinavian Fauna), while the great variety of form renders it extremely hard to find constant characters, which hold good for the regular forms, as well as for the anomalous ones connected with them by more or less distinct intermediate forms. Among the *Lysipharyngei* one may trace several distinct directions of development, which sometimes run parallel to each other, and sometimes suddenly deviate into strange anomalies. These directions of development ought to be systematically expressed in the division into families and groups. This is, however, rendered difficult partly by the anomalies mentioned above, and partly by the resemblances, often highly remarkable, between the lower stages of development in different families. Up to the present, it is true, we have only isolated observations of the variations of development — the principal works on this subject are LÜTKEN's *Spolia Atlantica*[e], in which work a list is given of the rest of the literature on this point, and GÜNTHER's *Andrew Garretts Fische der Südsee*[f]. This much, however, may be said of the result of these observations, that during the development of some of the Acanthopterygians there occurs a juvenile period which reminds us of the Ganoid type. As instances of this we may give the *Tholichthys* stage of the *Chætodon* family[a], the *Cephalacanthus* stage of the *Swordfish*[b], and the *Rhynchichtys* stage for the *Berycides*[c]. The latter, however, as they are included in the great series of the Percomorph families, are themselves to be regarded as similar mementoes. With this point also is connected the denticulation of the preoperculum[d] which appears during youth and subsequently disappears, in many forms of the great Scomberomorph series. In these common traces of an older type lies a band of union, which explains the difficulty of finding concise expressions of the family characters and of referring them to natural groups. Where the history of development has not yet taught us anything as to the natural relationship of the families to each other, there remains nothing, except to allow isolated characters to decide the point, though they may perhaps lead us to construct a more or less unnatural system.

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[a] The Linnean type specimen of ♂, the original of our figure, still exhibits distinct traces of the oblong, black spot behind the point of the pectoral fin and below the dentated, yellow band which runs along the sides of the body, and also of the anterior continuation of this spot, in the form of a narrow ribbon-like stripe, to the corner of the mouth. Cf. the figure given by WINTHER in *Zoologia Danica, Fish.*, pl. VIII, fig. 7.

[b] Vid. HANSEN in *Zool. Danica, Fiske*, p. 56.

[c] »Communissima» GIGLIOLI, Esposizione internazionale di Pesca in Berlino 1880, p. 95.

[d] = *Acanthopteri veri*, OWEN (p. p.) *Anat. Vert.*, Vol. I, p. 11.

[e] Dansk. Vid. Selsk. Skr., 5th R., Naturv. Math. Afh., XII. 6.

[f] Journal des Museum Godeffroy. See also his later work: *An Introduction to the Study of Fishes* (*Handbuch der Ichthyologie*), Cap. XIII.

According to the precedent set by Günther[e], but with those alterations which seem to be rendered necessary by the attempts of later writers[f] to systematize, we shall arrange the families of the Scandinavian Fauna that belong to this division, in accordance with the views that seem to us the most natural. The *Acanthopterygii Lysipharyngei* seem to us most naturally suited for a primary classification in two great divisions, limited according to the structure of the caudal and paired fins. Among the latter, the ventral fins vary in situation and in composition; and the pectoral exhibit a considerable difference in breadth, a difference which also affects the shape of the basal bones of these fins. Besides these differences, there is also in most cases a difference in the composition of the caudal fin, most easily expressed in the number of the branched rays of this fin. In those *Lysipharyngei* which in most other respects are the most regular, the ventral fins are placed below the pectoral, or just behind the perpendicular from the base of the latter fins (*Acanthopterygii thoracici*), and consist most often of one spinous ray and five soft rays. The pectoral fins are comparatively narrow (*Ac. stenobrachii*), and the basal bones generally narrow and shaped like a sand-glass: the number of branched rays in the caudal fin is comparatively larger (*Ac. euryripidi*). This division of *Lysipharyngei* may be called *Idiopteri*[g] on account of the regularity of the structure of their fins. The second division may also, it is true, possess thoracic and regular ventral fins. But most commonly these fins have fewer rays, are changed into organs of walking or adhesion, or situated on the abdomen (*Ac. abdominales*) at some distance behind the pectoral fins, or sometimes before the latter on the throat (*Ac. jugulares*). The pectorals are generally broad at the base, or their basal bones at least are broad and flat (*Ac. eurybrachii*) or abnormally developed in some other way (*pediculati*). The caudal fin has fewer branched rays[h], generally less than 15 (*Ac. stenoripidi*). This division we shall call *Anomalopteri*[i].

In addition to the characters of these divisons which we have now described, there also exists a biological difference between them. The first division contains, generally speaking, fishes of an active way of life, whether they be shore-fishes, wandering pelagic fishes, or deep-sea fishes. The second division includes, on the contrary, bottom-fishes of a more quiet and sluggish way of life. The more marked this way of life is, the more distinctly do these characters appear; and if the mode of life be changed, there may generally be observed, both in the shape of the body and in the other characters, an apparent transition in the direction of the other type.

The types around which most of the other *Idiopteri* may most conveniently be arranged in families are, in the Scandinavian Fauna, the Perch and the Mackerel, which may therefore each give their names to one of the series here described, series which, from a systematical point of view, are correlative to that of the *Pharyngognathi*.

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[a] Lütken, *Spol.* tab. V, fig. 7—11.

[b] Günther, Journ. Mus. Geoffr., Bd. I, p. 170 (Heft. 2, p. 98); Lütken, *Spol.*, Tab. II, fig. 11.

[c] Lütken, *Spol.*, Tab. II, fig. 4—7.

[d] Lütken, *Spol.*, Tab. III and IV.

[e] *Brit. Mus. Cat.*, *Fish.*, Systematic Synopsis of Acanthopt. Fish. (App. to Vol. III) and *An Introd. to the Study of Fishes*, p. 374, *Handb. d. Ichth.*, pp. 263 etc.

[f] Cope, *Contr. to the Ichth. of the Lesser Antilles*, Trans. Am. Phil. Soc.. Vol. XIV, n. ser., Art. V, p. 445. — Fitzinger, *Vers. einer Natürl. Classif. d. Fische*, Sitzber. Akad. Wiss. Wien, Math. Naturv. Cl., Bd. LXVII, Abth. 1, p. 5. — Gill, *Arrang. Fam. of Fishes*, Smiths. Misc. Coll., vol. XI, Art. 11 (n:o 247). — Jordan & Gilbert, *Syn. Fish. N. Am.*, Bull. U. S. Nat.. Mus. n:o 16.

[g] *Orthocormi thoracopteri* (p. p.) Fitzinger, l. c., p. 28.

[h] Such exceptions as *Gobius lanceolatus*, for instance, clearly depend upon the fact that the supporting rays of the caudal fin (at the top and bottom) are also branched.

[i] *Orthocormi pseudogastropteri* (p. p.) + *Heterocormi acanthopteri* + *Anomali pediculati*, Fitz. l. c. pp. 34, 39, 48.

PERCOMORPHI.[a]

The families of the Percomorph series, with scales usually ctenoid and uniformly covering the whole body, are further distinguished by the lateral compression of the body, which is more or less deep even at the peduncle of the tail, and also by the general strength of the spinous rays in the dorsal, anal and ventral fins. The suborbital ring has no osseous connection with the preoperculum.

Although we have just stated that one of the characters which distinguish most of the forms within this series, namely the denticulation of the preoperculum, may appear in the mackerel-series as a character of the younger specimens, thus showing that the latter series has, in this respect at least, reached a higher degree of metamorphosis, still, according to established custom and the precedent set by CUVIER, we place the Percomorph series first. It is this type that gives the clearest idea of the perfection of the Eleutherognates, for in it no special organic system has been stunted or developed at the expense of the others and thus in any respect caused a distortion of the regularity of the Teleosteous form.

The families of the Scandinavian Fauna which belong to this series may be distinguished by means of the following scheme.

- I: Ventral fins regular, with 1 spinous and 5 soft rays.
  - *A:* Branchiostegal rays at least 5. Chin without or with only rudimentary barbels.
    - *a:* Preorbital bone covering only the anterior and superior parts of the maxillary bone when the mouth is closed.
      - *α:* Vomer with teeth .... *Percidæ.*
      - *β:* Vomer toothless .... *Sciænidæ.*
    - *b:* Preorbital bone covering the whole of the maxillary bone, when the mouth is closed *Sparidæ.*
  - *B:* Branchiostegal rays 4. Chin with large and mobile barbels .... *Mullidæ.*
- II: Ventral fins with 1 spinous ray and more (or less) than 5 soft rays .... *Berycidæ.*

FAM. **PERCIDÆ.**

Exterior bones of the head, at least the preoperculum, jagged or denticulated. Scales denticulated. Spinous-rayed part of the dorsal fin or the anterior dorsal fin without scales, and longer than the soft-rayed part or posterior dorsal fin. Simple, conical teeth on the lower jaw, the intermaxillary bones, the vomer and the palatine bones. The ventral fins thoracic, with one spinous and five soft rays. Chin without barbels.

In number of species the Percoid family is one of the largest among the *Teleostei*. GÜNTHER gives in his *Catalogue* more than 700 species which must be referred to this family according to his later opinion[b]. They belong to the salt and fresh waters of the tropical and temperate zones: only a few are met with north of the polar circle, and among these we find just those species which belong to Scandinavia. Their geological age is, as far as we know, not great, but one species of the true genus *Perca* has been found in the Miocene strata at Oeningen. The genera which belong to the Scandinavian Fauna may be distinguished by means of the following scheme:

- *A:* Anal fin with 2 spinous rays. (Number of vertebræ 30—45: *Percinæ*)
  - *a:* Two dorsal fins.
    - *α:* The teeth of the jaws and palate equal in height (no canine teeth)........ *Perca.*
    - *β:* Between the jaw-teeth and the palatine teeth large canine teeth far apart from each other .... *Stizostedium.*
  - *b:* One dorsal fin .... *Acerina*
- *B:* Anal fin with 3 spinous rays. (Number of vertebræ about 24: *Serraninæ*)
  - *a:* Two dorsal fins .... *Roccus.*
  - *b:* One dorsal fin .... *Polyprion.*

Each of these genera is represented in our Fauna by only one species. On that account, and because the Scandinavian forms which belong to this family are not so numerous as to render it difficult to distinguish them without any further division of the family, we have departed from the later opinion of GÜNTHER and others who have followed him, according to which these fishes should be divided into two families. Some exception, too, may be taken to this arrangement, on the ground that the characters given therein draw a wide distinction between forms that are obviously most closely related in other respects, e. g. *Roccus* and *Perca*. The character given by GÜNTHER, as well as by JORDAN and GILBERT[a], as a distinction between these families, that the *Percidæ* have fewer pyloric appendages than the *Serranidæ*, does not hold good in the case of *Roccus*, as *R. labrax* has only 5 pyloric appendages[b]. The scheme given above shows, however, that in the Scandinavian Fauna we may follow the division proposed, whether we decide to employ only external characters, or internal ones which are not so easy to fix.

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[a] COPE, (p. p.) *Acanth. Perciformes*, GÜNTHER (p. p.)

[b] *Introd. Stud. Fish.*

GENUS PERCA.

The shape of the body an oblong oval, laterally compressed to some extent. The scales of average size, with sharply denticulated margin. A spine behind the gill-cover. The preoperculum, shoulder girdle and preorbital bones serrated. The cheeks scaly, but the upper part of the head naked. Small teeth, of equal size, set in cardiform bands, on the intermaxillary bones, the lower jaw, the vomer and the palatine bones. The tongue without teeth. Only 3 pyloric appendages. Pseudobranchiæ complete, though sometimes overgrown. Branchial membranes separate, each with 7 rays. In the anterior dorsal fin from 13 to 15 rays. In the anal fin 2 spinous rays; the base being shorter than that of the posterior dorsal fin. In the caudal fin at least 15 branched rays.

As our knowledge of *Perca Schrenckii* of Turkestan is only partial, and as JORDAN and GILBERT[c] have referred *Perca gracilis* of Canada to the common American perch, we can scarcely claim to know more than one species of the genus *Perca*, our common perch. This species, however, contains several varieties, which are spread over the east of North America, the whole of Europe and the west of Siberia, thus forming one of the remains of the prehistoric connection across the Atlantic between the Old World and the New[d].

THE PERCH.

PERCA FLUVIATILIS.

Plate 3, fig. 1.

$R.\ br.\ 7;\ D.\ 15^{e}\,\frac{2}{13^{f}};\ A.\ \frac{2}{8^{g}};\ P.\ 1+11+3^{h};\ V.\ {}^{1}{}_{5};\ C.\ x+15+x^{i};\ L.\ lat.\ 50—70.$

Syn. Perca fluviatilis et major auctorum, ART., *Gen. Pisc.*, p. 39; *Synon.*, p. 66; *Descr. Spec.*, p. 74.

Perca fluviatilis, LIN., *Syst. Nat.*, ed. X, p. 289; BLOCH, *Fische Deutschl.*, tab. LII; RETZ., *Fn. Suec. Lin.*, p. 335; CUV., VAL., *Hist. Nat. Poiss.*, II, p. 20; PALL, *Zoogr. R. As.*, III, p. 248; NILSS., *Prodr. Ichth. Scand.*, p. 81; EKSTR., WRIGHT, *Skand. Fiskar*, ed. 1, p. 1, tab. I, fig. 1; BONAP., *Icon. Fn. Ital.*, III, n:o 87, p. 79, tab. fig. 1; KRØYER, *Danm. Fiske*, I, p. 1; NILSS., *Skand. Fn.*, *Fisk.*, p. 5; GÜNTH., *Brit. Mus. Cat.*, *Fish.*, I, p. 58; SIEB., *Süsswasserf. Mitteleur.*, p. 44; COLL., *Norges Fiske*, Chr. Vid. Selsk. Forh. 1874, Tillægsh., p. 15; ibid. 1879, n:r 1, p. 5; MALM. *Gbgs*, *Boh. Fn.*, p. 374; WINTHER, *Zool. Dan.*, *Fiske*, p. 2, tab. I, fig. 1; FEDDERSEN, Naturh. Tidskr. Kbhvn, 3 R., XII, p. 71; DAY, *Fish. G:t Brit.*, *Irel.*, I, p. 2; LILLJEBORG, *Sv.*, *Norg. Fiskar*, I, p. 46; REUTER et SUNDMAN, *Finl. Fisk.*, tab. IX.

Perca vulgaris, GRONOVIUS et SCHÆFFER; *P. helvetica*, GRON.; vide GÜNTHER, l. c. et SIEBOLD, l. c.

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[a] *Syn. Fish. N. Amer.*, l. c., pp. 486 and 527.

[b] Cf. DAY, *Fish. G:t Brit.*, *Irel.*, pt. I, p. 9.

[c] *Syn. Fish. N. Amer.*, l. c., p. 524.

[d] SMITT: *Ur vår tids forskning* no. 29, pp. 58, etc.

[e] Sometimes 14, in the American variety sometimes 13.

[f] » 14.

[g] » 9.

[h] 2 + 10 + 2 or 2 + 9 + 3. The middle figures indicate the number of the branched rays.

[i] $x + 16 + x$. The middle figure indicates the number of the branched rays.

Perca italica, Cuv., Val., l. c., p. 45.

Bodianus flavescens, Mitschill, Trans. Soc. N. York, I, p. 421; Cuv., Val. (*Perca*), l. c., p. 46; Steindachner, Sitzber. Akad. Wiss. Wien, LXXVIII, Abth. 1, p. 399.

Perca serrato-granulata, *P. granulata*, *P. acuta*, *P. gracilis*, Cuv., Val., l. c., pp. 47—50.

Perca americana, Schrank, Gill; vide Jord. et Gilb., *Syn. Fish, N. Amer.*, l. c., p. 524.

Obs. Günther[a], Steindachner[b] and Day[c] have all three stated that the North American *Perca flavescens*, which is spread over the east of the United States and Canada, should be reckoned as a variety of the same species as the European perch. This opinion has, however, been subsequently contradicted most flatly by Jordan and Gilbert[d]. Most of the characters given by the last-named authors as distinguishing between the two supposed species, have already been disproved by Day (1880), who pointed out the want of uniformity in the American perches with regard to the length of the head, the roughness of the body, the stripes, the spines of the bones, the number of the fin rays and of the rows of scales. However, Jordan and Gilbert (1882) adduce, as a foundation for this distinction of species, some further circumstances[e], to investigate the truth of which we have examined 4 specimens which we have received through the Smithsonian Institution. Two of these specimens are from the Potomac and about 190 mm. in length; the third from Pekin in Illinois, and 183 mm. in length, and the fourth from Connecticut River, and 118 mm. in length. On comparing these specimens with each other and with European specimens, we found that the most modern evidence to prove a difference of species is also untenable. In the European perch, it is true, the scales are smaller and the first dorsal fin begins more forward than in the American. The latter point is shown most clearly by the fact that in the European perch a row of scales from the beginning of this fin downwards in an oblique, forward direction, generally meets the lateral line at the first scale, and contains 8 or 9 scales, while in the American variety it generally meets the lateral line at the third or fourth scale, and contains 5 or 6 scales. In one of the specimens from the Potomac, however, the line contains 8 scales, and meets the lateral line at the first scale. In these American specimens the gill-rakers are not a bit broader than in the European perch of the same size. In the smallest specimen from America the pseudobranchiæ resemble true gills as closely as in the European perch, but in the larger ones they are covered (»glandulous»), a peculiarity which may also be observed in older specimens of the European perch. Thus, no difference of species has yet been proved between the European perch and the American. However, the wide geographical separation which has so long existed, has not failed here, as well as in other similar cases, to leave traces of the influence of the different natural environments on the form of the fish. The European perch has generally a greater number of spinous rays in the first dorsal fin, and the base of this fin is generally longer in the European perch than in the American. The length of the base in proportion to the length of the body increases with age, so that in the European perch about 200 mm. in length the base of this fin is on an average, according to measurements taken from newly-caught specimens, 32.9 % of the length of the body, while the corresponding average proportion in the European perch from 260 to 330 mm. in length, is 34.5 %. In the four specimens of the American perch[f] mentioned above, which are preserved in spirits, the corresponding average is 28 %, while in still smaller specimens of the European perch, also preserved in spirits, and from 106 to 109 mm. in length, it is 29.7 %. In the smallest European perch that we have measured, $36^{1}/_{2}$ mm. in length, the proportion was 26 %. The tendency of these changes due to age shows that the European type is more highly developed than the American. The least depth of the tail too is proportionally greater in the American perch, and also in younger specimens in contradistinction to older ones[g]; but the length of the base of the anal fin in proportion to the length of the body, seems, on the contrary, to diminish with age, and is less in the American type than in the European[h]. This contrast in the course of development among these fishes, to judge by the specimens before us, causes a radical difference, which is most clearly shown by the fact that the least depth of the tail is less than 75 % of the base of the anal fin in the European perch, while in the American it is at least 93 %. We should be compelled to acknowledge that so important a character constitutes a difference in species, but for the fact that it does not hold good in abnormal specimens of the European perch, e. g. the so-called Carass Perch. The great similarity in various respects between *Perca fluviatilis* and *P. americana*, which has already been proved by the authors quoted above, renders it most natural to regard these forms as varieties of the same species, which, during a geographical separation of long duration, have deviated in certain respects from each other's course of development.

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[a] *Cat.*, l. c. p. 50.

[b] *Sitzber.*, l. c. Cf. also Proc. U. S. Nat. Mus., vol. I, p. 243.

[c] *Fish.*, l. c.

[d] *Syn.*, l. c.

[e] "The most important characters, the difference in the insertion of the dorsal, and in the gill-rakers and pseudobranchiæ, have not been noticed by those writers who have decided that our species is identical with the European."

[f] With regard to the character given by Jordan and Gilbert, that in the American perch the first spinous rays in the anterior dorsal fin are shorter than the corresponding rays in *P. fluviatilis*, we may state the difference in this respect between the two specimens from the Potomac, which are almost equal in size. In one of these specimens the first spinous ray is about half as long as the second, which in its turn is about $^{2}/_{3}$ of the third in length. In the other specimen the length of the first ray in proportion to the second is about the same as that of the second to the third in the first-mentioned specimen. The latter too has 14 spinous rays in the first dorsal fin, while the second specimen has only 13, i. e. the first spinous ray is wanting. Again, the first specimen has a black patch on the anterior and also on the posterior portion of the first dorsal fin, while in the second these spots are absent.

[g] In the European perch we have found the least depth of the tail in specimens $36^{1}/_{2}$ mm. in length and preserved in spirits to be 27 % of the length of the head, in newly-caught specimens on an average 210 mm. in length, 25.8 %, and in newly-caught specimens on an average 291 mm. in length 24,1 %. The minimum proportion thus found was 23.8, the maximum 27. In the American specimens mentioned above, which are preserved in spirits, and on an average 169 mm. in length, the least depth of the tail is on an average 29.9 % of the length of the head, the minimum being 29.3 %, the maximum 30.6 %.

[h] In the European variety the base of the anal fin is more than, equal to, or only a little less than 10 % of the length of the body: in 13 measured specimens it turned out to be at least 9.4 %. In the American specimens mentioned above it is at most 8.6 % of the length of the body. The number of rays in this fin varies also in these specimens between $^{2}/_{6}$ and $^{2}/_{8}$.

The Perch is a fish of such common occurrence, that there are probably few persons who require to consult a description in order to recognize it. Its body is compressed, broadest anteriorly, and covered with hard scales, not easy to detach, and rough on account of the hooks, as fine as hair, which fringe their outer edge and are directed upwards.[a] The head is fairly large,[b] compressed and somewhat pointed: the eyes are of average size,[c] the jaws of equal length, the nostrils large with a double opening, the mouth also large, the jaws, the vomer the palatine bones and the pharyngeals covered with teeth. The back, which is somewhat elevated anteriorly, is furnished with two distinct fins. The lateral line arched and nearer the back than the belly. The first dorsal fin yellowish gray without spots, excepting a black spot towards the termination (sometimes at the beginning as well): it begins just over the insertion of the pectoral fins and ends in a line with the vent. The second dorsal fin, the ground colour of which is the same, begins close to the end of the first, and ends a little behind the termination of the anal fin.

The body is grayish yellow, darker towards the back, and marked with grayish black, transverse bands, generally six in number, the middle ones being branched at the top and ending in a point at the bottom: the belly is white. The colouring of the fish varies greatly according to age and the season of the year, and is also considerably affected by the nature of the bottom and the composition of the water it inhabits. The young specimens are always lighter than the old, their colours being dirtier and their coloration less distinct. During the spawning season the colouring of the males is brighter and more distinct, and becomes still more so in summer, the season when the Perch collects in shoals. The specimens which live near stony shores and in clear water, are always of brighter colour than those which frequent places where the bottom is weedy and muddy, and thus acquire a faint and sickly colour. In dark, but clear water, such as we often see in forest lakes, the colouring of the fish is always darker than usual, and the inferior fins and the tail are bright red.

The saccate part of the intestinal canal, or the stomach, is comparatively large. The intestinal canal forms two curves and has three pyloric appendages attached a little below the stomach. The liver consists of two lobes, the left one being the larger. The gall-bladder is yellow and clear. The male has two milt-sacs, but the female only one roe-sac. The air-bladder is large, and occupies a considerable part of the abdominal cavity. The kidneys are placed lengthwise below the spinal column. The bladder is saccate. There are 20 or 21 ribs on each side, and the vertebræ are 41 or 42 in number.

The Perch is one of the most widely spread Scandinavian fishes. It is found at Kilspisjärvi (lat. 50° N.) in Torneå Lappmark, and occurs too in Norway, where it is called in some places *Tryte.*[d] One may therefore assume that, south of the degree of latitude mentioned above, it occurs more or less plentifully in all Swedish waters. It does not disappear even in lakes that are very considerably above the level of the sea. Though it often occurs in shallow lakes with a weedy and muddy bottom, it thrives best in deep and clear water where the bottom is stony, and best of all where there is some current. In the sea it occurs oftenest on the landward side of the island-belt, and especially at spots where a river falls into the sea and diminishes the saltness of the water. However, it is also found, though more seldom, within the Baltic in the outer part of the island-belt where the open sea begins. It is believed that the Perch thrives best in northern latitudes, since it there attains its largest

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[a] These hooks (spines) are not present in the newly-formed scales, which are cycloid (vid. Winther, *Naturh. Tidskr. Kbhvn*, 3 R., 8 B., pp. 28 etc., Plate XVI), but soon become ctenoid, as the margin develops into 1, 3, 5, etc. spines (though the number is not always odd), which afterwards become dentoid in substance, and from time to time during their growth become detached at the root, though they are still united to the surface of the scale, which continues to grow beneath them. In this way they eventually become fixed to the hind margin of the scale, though the fragments of their former roots remain, arranged in rows directed towards the central part of the scale and indicating the place, where their development originally began.

[b] In a specimen $36^1/_2$ mm. in length the length of the head is 30 % of the length of the body. Where the length of body is on an average 207 mm., the length of the head has proved to be on an average 27.6 % of the length of body, where the length of the body is on an average 262 mm., 26.7 %, and where it is 308 mm., 27.5 %.

[c] Length of the body on an average 210 mm., longitudinal diameter of the eyes on an average 17.2 % of the length of the head. Length of the body on an average 275 mm., longitudinal diameter of the eyes on an average 15.5 % of the length of the head. Length of the body on an average 308 mm., longitudinal diameter of the eyes on an average 14.3 % of the length of the head.

[d] Its range in Norway is confined, however, according to Collett, to the northern and southern (not the central) parts. "As is the case with several of our fresh-water fishes, it chiefly (or perhaps exclusively) inhabits two extensive districts far apart from each other, namely the inland parts in the east, south of Dovre, where it has immigrated from Sweden, and Finmark, where it has originally come from the north-east". Coll., 1879, l. c.

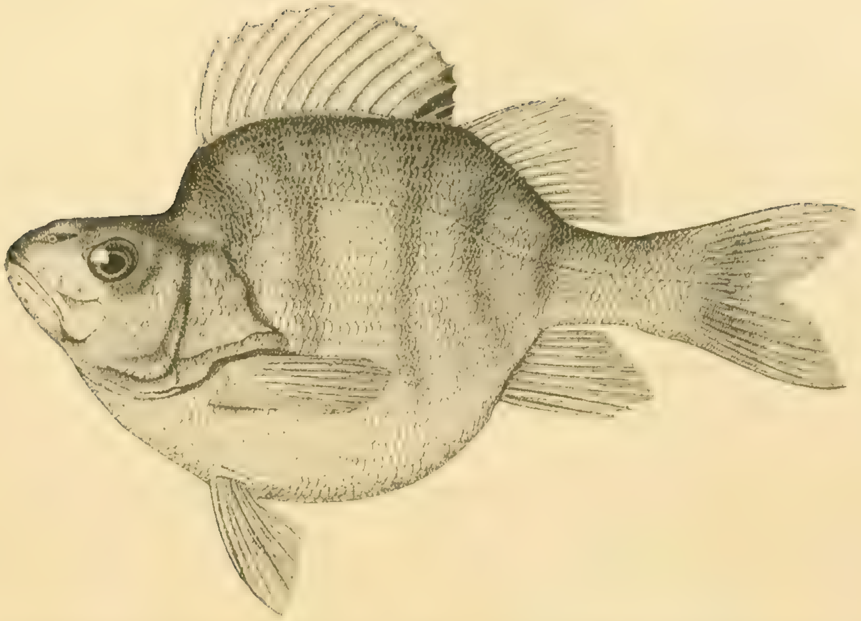

Fig. 3. *Carass perch* (*Rudabborre*, *Perca fluviatilis*, *var. gibba*) from Lake Elgsjö in Östergötland. $^1/_2$ of the natural size.

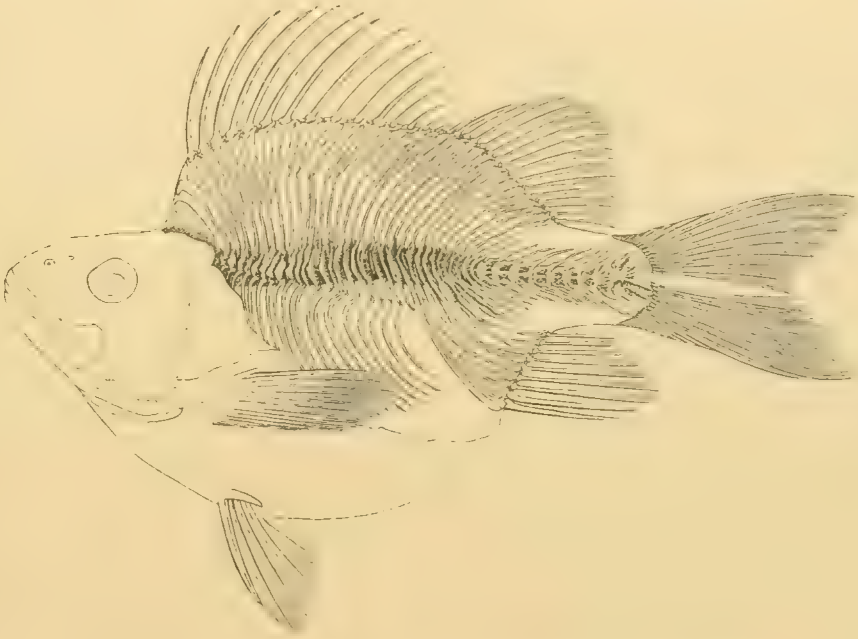

Fig. 4. Skeleton of the Carass Perch externally figured above.

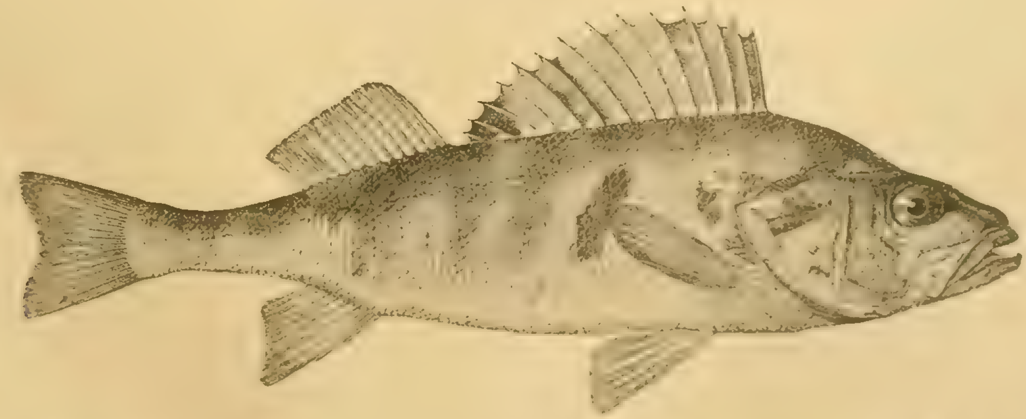

Fig. 5. Spotted Perch (*Skålling*, *Perca fluviatilis*, *var. maculata*) from Lake Tisaren in Nerike. $^2/_3$ of the natural size.

size[a]. In central Sweden the largest examples occur in lakes which have steep, rocky shores and deep bights. The weight of the fish, however, seldom exceeds four and a half pounds.

The Swedish fishermen draw a distinction between the *Ice Perch*, *Leaf Perch*, *Stone Perch*, *Mud Perch*, *Deep-water Perch*, and *Sedge Perch*. But the differences which have given rise to these several names, are due partly to the dissimilarity in the haunts of the fish, and partly to certain local or fortuitous circumstances which have a varying influence upon the spawning-season, rendering it earlier or later, and upon the appearance and flavour of the fish. The so-called Carass Perch which Linnæus found in the meres near Falun[b], has also been found in many other places both in Sweden and Finland, as well as in England. Wahlgren has shown[c] that this change in form is due to an abnormal shortening of the vertebrae (rachitis), but this misformation may sometimes be peculiarly regular in character, as is shown in figs. 3 and 4, p. 29, drawn from specimens taken in Lake Elgsjö in the neighbourhood of Vadstena and handed over by Dr. Cnattingius to the Royal Museum. From Lake Tisaren in Nerike the Royal Museum has acquired, through President af Robson (1837), a peculiar variety of the Perch, called by Sundevall *var. maculata* (fig. 5), and known to the fishermen by the name of *Skålling*. "Their spawn," writes Robson, "is unknown, they have never been found to have milt or roe. They resemble the common Perch, but are more slender, being thin and lean. The head is larger in proportion to the body than in the common Perch. The head black, the rest of the body, on the contrary, lighter or fainter in colour than is the usual case with the Perch. They generally swim alone or in extremely small companies, never collect in shoals, occur seldom, and rarely exceed $7^1/_2$ oz. in weight." The appearance and habits of the so-called *'bottengnidare'* (bottom rubber) of Södermanland, are identically the same as those of this variety. Our figure of the Spotted Perch is further designed to recall to the reader's mind the similarity to the American perch that results from the ridges which may occur on the gill-cover. A third variety (*aurea* or the Golden Perch) has been described by Sundevall[d], who took his description from a specimen from Eskilstuna which was handed over to the Royal Museum by Mr. Linder. "During life," he says, "the colouring throughout the body was a decided orange, a little redder than the colour of the small, common Gold Fish, with only indistinct traces of black spots on the back." It seems evident that in this case too some kind of sickliness has given rise to this variation of form, from the juvenile characters which this specimen has retained, notably in the comparatively large size of the eyes and the length of the ventral fins[e].

The sullen and sour disposition of the Perch seems to be the reason why it prefers a solitary life, and only joins its fellows during the spawning-season in spring and at midsummer, when it collects in shoals. At all other seasons only solitary individuals are found, but in winter one may see it collected in groups at certain places. It generally keeps near the bottom, and, though a fairly fast swimmer, remains motionless for long intervals at the same spot; and awaits its prey oftener than it seeks it. At need, however, it is very quick in its movements, and when on the point of attacking its prey, or itself in fear of the assault of some foe, it spreads its fins, apparently as a sign that it is destitute neither of courage nor of weapons.

The Perch is very tenacious of life, and may be kept alive for a long time in a cauf, if this be placed in slowly running water. In a packing of wet grass it bears long journeys without dying. Its growth is supposed to be slow[f], and it is not capable of propagating its species until three or four years old[a]. This may be very much influenced, however, by the abundance or scarcity of its food, which consists of small fry, roe, insects and worms.

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[a] Scheffer's account (*Lapponia*, Francoforti 1673, p. 354) of a perch the head of which was *6 inches broad*, and was preserved in Luleå church, probably refers to some other fish, perhaps the Pike-perch or the Pike; Cuvier assumed it to have been a Norway Haddock (*Sebastes*).

[b] *Fauna Suecica* (1746), p. 106.

[c] *Öfvers. Vet.-Akad. Förh.* 1873, no. 8, p. 61.

[d] *Öfvers. Vet.-Akad. Förh.* 1851, p. 155. Malm too has described a similar variety in *Gbgs, Boh. Fn.* p. 377.

[e] The length of this specimen from the tip of the snout to the middle point of the caudal rays is 220 mm. The longitudinal diameter of the eye is 19.3 % of the length of the head, while the normal diameter is not more than 17 %. The length of the ventral fins is 65 % of the distance from the insertion of these fins to the beginning of the anal fin, while it is only in young specimens from 30 to 40 mm. in length that I have found this ratio to be as high as 60 %: in specimens about 200 mm. in length it falls to about 50 %, and in specimens of the common perch 300 mm. in length it was from 43 to 45 %.

[f] According to Mäklin (see Reuter, *Finl. Fisk.*) the Perch is on an average:

when 1 year old, 86.5 mm. in length; when 3 years old, 179.2 mm. in length; when 5 years old, 264 mm. in length.
2 127.3 4 224.3

The spawning-season varies according to the depth of the water; in shallow lakes it is often earlier than the middle of April, but in deeper water, in Lake Wetter and the island-belts for example, not before the middle of May, and generally towards the end of that month. It is also much influenced by the temperature and the earliness or lateness of the spring. When the spawning-season has arrived, or, more correctly, some days before its arrival, the Perch leaves the deep water where it has passed the winter, and, collected in large shoals, wanders to points along the shore where the water is shallow and the bottom consists of stones or sand covered with reeds (*Arundo phragmites*), or where it can find sunken twigs and branches. If it fails to find any spots of this nature, it deposits its spawn among tufts of rushes (*Scirpus*) and horse-tail (*Equisetum*). The roe of the Perch is not made up, as is generally the case among fishes, of loose grains covered only with a viscid mucus and easily detached from each other as soon as the roe is deposited, but is enveloped in a netty membrane which holds the grains more closely together, and renders it necessary for the female to make greater effort and to have recourse to special expedients in order to free herself from the roe. It is said[b] that in the spawning-season the female rubs her belly against a sharp stone or a piece of wood, until she succeeds in fastening the roe-string to this object, whatever it may be. She then darts suddenly forward with a winding motion, and thus draws out the roe in the form of a string which in some way resembles the strings of spawn which certain batrachians deposit. Now and again, however, the roe is found lying loose on some water-plant[c] or drifting about in the water[d]. The eggs are numerous, but their number varies considerably in proportion to the size of the fish. In a female weighing about 255 grammes LUND estimated the number of the eggs to be 26,880, and in another weighing about 584 grammes, 66,150. In a female 2 lbs. 9$^1/_4$ oz. in weight BLOCH[e] estimated the number of the eggs to be 268,800. From these estimates we may imagine how quickly the Perch might multiply. That it does not do so, may be ascribed to the fact that the roe is in one mass, and is thus more liable to be devoured by fishes of prey and waterfowl, or in stormy weather cast on the shore, where it dries up, etc. It is also probable that it is impossible for the milt of the male to fertilize all the eggs enclosed in the roe-sheath.

As a general rule, the males seem to be less numerous than the females — among twenty perch bought at the same time in a market-place in Stockholm, there were only three males, and all three were among the smallest of the twenty. No external distinction as to sex was visible at this time (in December). The opinion that the female (according to others, the male) has a greater depth of body or a smaller head, was not borne out by fact. It is during the spawning-season that the difference of sex first becomes apparent in the brighter and more vivid colouring of the male and the deeper shape of the female, which is perhaps always visible at this season[f].

The courage with which it defends itself, and the formidable weapons against fishes of prey which it possesses in its spinous fins, tend to preserve the Perch from attack as soon as it has reached an age when it can defend itself. It swims rapidly, but not continuously. After each dart forwards it stops for a moment. It generally keeps close to the bottom, and sometimes half-way between the bottom and the surface. It is only on bright and calm summer days that it disports itself at the surface. About midsummer comes the time

In the beginning of Dec., 1886, among females with eggs about 1 mm. in size, we have found

the weight of specimens	266 mm. long to be	281 grm.,	the weight of specimens	288 mm. long to be	361 grm.,
—	278	276	—	305	361
—	281	332	—	330	553

[a] NORBÄCK (*Fiskevård och Fiskafvel*, p. 359) and MÄKLIN (l. c.) state that the Perch is capable of propagating itself when two years old. That this holds good in the case of the males, is undoubtedly true, at least if the estimate of age given above be correct, for in Lilla Värtan (a firth of the Baltic near Stockholm) on 12th of May, 1887, males 127 mm. in length (measured to the end of the middle rays in the caudal fin) were found to have fluid milt. The smallest female ready to deposit its spawn, which was caught on the same occasion, measured 154 mm. in length.

[b] LUND, *Vet.-Akad. Handl.* 1761, p. 188.

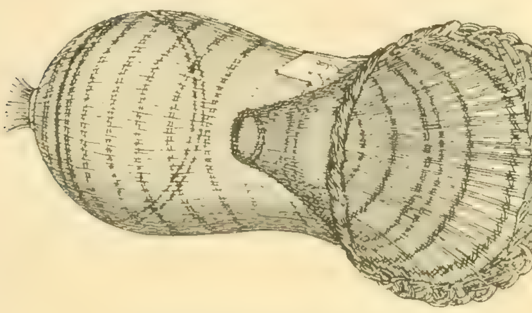
[c] MALM, *Gbgs, Boh. Fn.*, p. 377.

[d] SUNDEVALL, Vet.-Akad. Handl. 1855, p. 9.

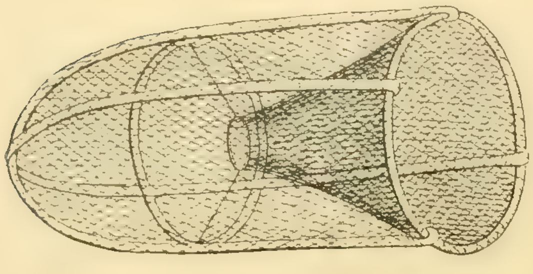
[e] *Naturg. Fische Deutschl.*, 2 Th., p. 68.

[f] The truth of this statement is most clearly shown by the fact that in the case of 3 males and 4 females the least depth of the body, or the least depth of the tail was more than 30 % of the greatest depth of the body, while in the females it was less than 30 %.

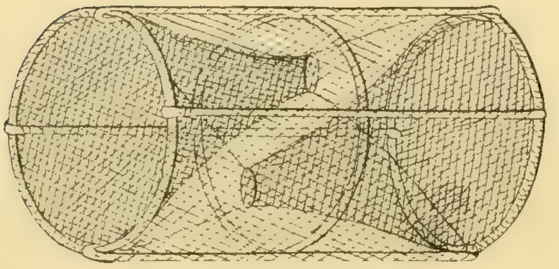
Fig. 6. Different sorts of traps for fresh-water fishing.



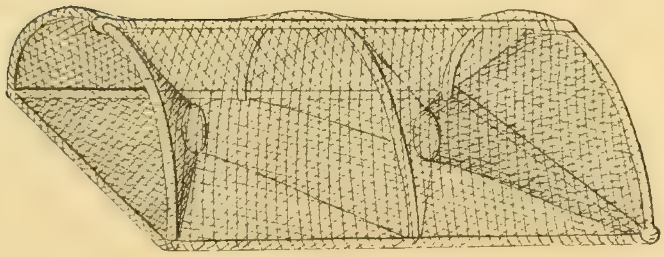
a: wicker-work trap (*videmjärde*).



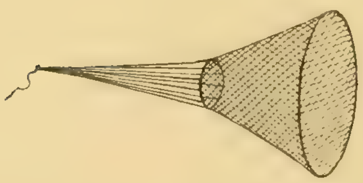
b: network trap (*garnmjärde*),



c: sinking trap (*sankmjärde*),



d: flat-bottomed sinking trap.



e: method of fixing the funnel in the trap.

when it collects in shoals. It then assembles in large or small bodies and makes its way to shallow spots in the creeks where it is sure of finding small fry and insects. At this time its movements are very quick and active, and it may often be seen to leap out of the water in its pursuit of the smaller fishes. During the chase it suddenly slaps the surface of the water with its tail and thus produces a sound not unlike that of expectoration. The fisherman imitates this sound by snapping his fingers in the water, and some persons believe that by this means they can entice the fish to the place whence the sound proceeds.

As we have already mentioned, the Perch is a fish of prey, and since on account of its courage and daring it has no difficulty in finding food, and does not remain at other spots than those where it can procure food in abundance, it is generally in good condition all the year round. Its flesh is white, firm and wholesome, and has the peculiarity, uncommon among fishes, that one can eat it daily for a long time without becoming tired of it. The flavour of the fish greatly depends, however, upon the nature of the water it inhabits. Those perch which are caught in shallow lakes with a grassy bottom are smaller, leaner and of worse flavour than those which are taken in larger lakes with a stony bottom and deep, clear, running water. The salt-water Perch is the most highly esteemed, and holds in Sweden the same place as the Rhine Perch has long held in France and the Perch of Lake Leman in Switzerland. In domestic economy this fish would be of much more value, if it could be preserved for future use without losing too much of its flavour. This is, however, an impossibility. It has been sometimes salted, sometimes dried, but the delicate flavour which the fish possesses when eaten fresh, entirely disappears under this process. It is only poor people who dry the Perch in the sun and eat it to stay their hunger; among people in better circumstances it is always sent to table fresh. Experience has also taught us that the Perch cannot be kept long out of the water before its flesh loses flavour. In order to avoid this, recourse is sometimes had to the expedient of throwing the fish into the pan alive and boiling it without cleaning it at all.

It is natural that a fish so valuable for culinary purposes should be eagerly sought after. In spring the Perch is caught in traps (*mjärdar*, fig. 6) at the spots where it deposits its spawn. The traps are either large, in which case they are set in a kind of weir (*verke*), or small, in which case they are set singly and are called sinking-traps. The '*verke*' is a method of fishing practised in the North from prehistoric times. Parallel rows of stakes are fixed in the bottom of the lake, and the spaces between them are alternately filled with pine-branches or left open to receive the traps. This weir is constructed at the spot where the Perch spawns, which is generally at the edge of the reeds, and a place is usually selected where the water is so deep that two or three traps may be laid on the top of each other without projecting above the surface. More attention should be paid, however, to the nature of the place than to the depth of the water, and the weir should be constructed close to the edge of the reeds. When the traps have been set, the weir is covered with large pine-branches full of needles, in order that its interior may be only dimly lighted.

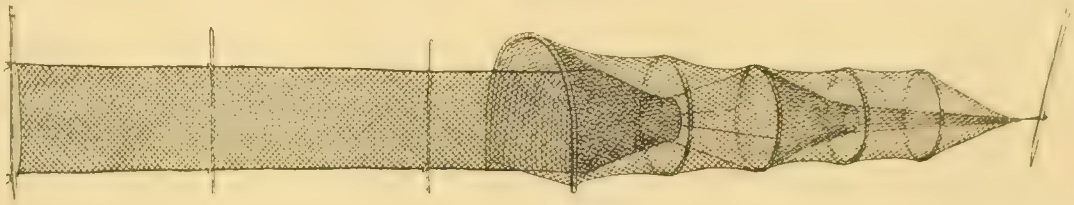


Fig. 7. Ryssja.

The sinking-traps are generally set singly at a distance of some yards from each other; they are used in places where the water is so deep or the bottom so stony that a weir cannot be constructed. These traps, or sometimes the kind of traps called *'ryssja'* (fig. 7), are also set in narrow straits or streamlets between neighbouring lakes, for the Perch most often makes its way to the spawning-place through channels of this nature. At the entrance of the straits or the mouth of the river, standing nets (*läggnät*), are set at the edge of the reeds near the spawning-place. These nets have their advantages, and may be used during the whole summer. They only require to be taken up in the morning and set at night, operations which do not take much time. When the spawning-season is over, these nets are placed off stony headlands, in narrow creeks, etc.; and as all the fish hug the shore, or more strictly the edge of the reeds, they are always set at right angles to the shore, not parallel to it. At the time when the Perch have deposited their spawn and disperse in order to find their summer haunts, they are sometimes taken, though seldom in large numbers, in drag-nets. In order to have any success with the drag-net during summer, one must choose a cloudy day when there is a light breeze, or only go out at night. To use a drag-net on a bright summer day, is one of the most useless things one can do. During summer, with the exception of occasional catches in a net or drag-net, perch-fishing is generally carried on with rod and line. Angling for Perch is in many places one of the darling amusements of high and low, and a pleasure not disdained even by the fair sex. There are several modes of angling for Perch, and a description of them is necessary. One must first pay attention not only to the time of year, but also to the hour of day, best suited for angling. Ascension Day is known by fishermen as the first day for angling. This is not quite correct every year, but still it roughly gives us the time. The surest guide is given by the growth of a reed, *Arundo phragmites*. As soon as this plant has grown to a height of an inch or two above the surface of the water, the spawning-season of the Perch is over, and one can then with all certainty begin fishing. The best season, we may take it, begins in the last days of May and ends at the beginning of September. The best time of day is from sunrise till 9 a. m. and from 6 p. m. till sunset. With regard to the weather we may say that cloudy days are better than very bright ones, and a light breeze than a dead calm. All fishes bite best just after rain, especially if it has lasted long. The most suitable spots are generally well known. A stranger to the water should choose a spot at the edge of the reeds, off stony headlands and in places where there are sunken twigs and tree-trunks (Sw. *lågor*). At such spots are generally to be found numbers of bleak, minnow and small fry of all kinds, a store of food of which the Perch does not omit to take advantage. In lakes where the shores do not offer such favourable spots for fishing, one may look for points out in the bights where the bottom is sandy or stony. If no such spots are to be found, one may form an artificial angling-place by sinking twigs and stones a little way from the shore.

As angling may be practised at spots of a different nature and in a variety of ways, special names have been invented for the various modes. When the angler stays on shore or close to land, it is called *shore-fishing*, but when he fishes at some distance from shore in deeper water, it is called *deep-water fishing*. In *shore-fishing* earth-worms are generally used as bait, the best being those taken from under old woodpiles or in unmanured soil, as the fish always prefers them to worms taken from dunghills. Insects, flies, gadflies, etc. may also be used, but only when the Perch rises to the surface, for at the bottom it takes such bait less freely. In *deep-water fishing* minnows are the most useful bait, and if earth-worms are employed, one should chose the lobworm, which may be caught by torchlight of an evening. The shelled tails of crayfish too are regarded by the Perch as a delicate morsel; but it is not easy to fasten them on the hook, they often fall off, and one must always put on a fresh one after every bite. At a pinch one may also make use of cheese. For this purpose new cheese is cut into slices, which are then kneaded in warm water and cut into the shape of worms. This bait does not dissolve in water, but still it is only a last resource. In putting the bait on the hook great care should be taken that the point of the hook is quite concealed. When small fish are used as bait, the hook should be inserted in the back with the point directed towards the head of the fish. When worms are used, one need only put on the hook a part of the worm large enough to conceal it entirely; but when the Perch bites less freely, the whole worm should be used, the hook being inserted in the thick end and the other end being allowed to trail behind. To insert the hook in the middle of the worm letting both ends dangle, as some people do, deserves to be called feeding, not fishing.

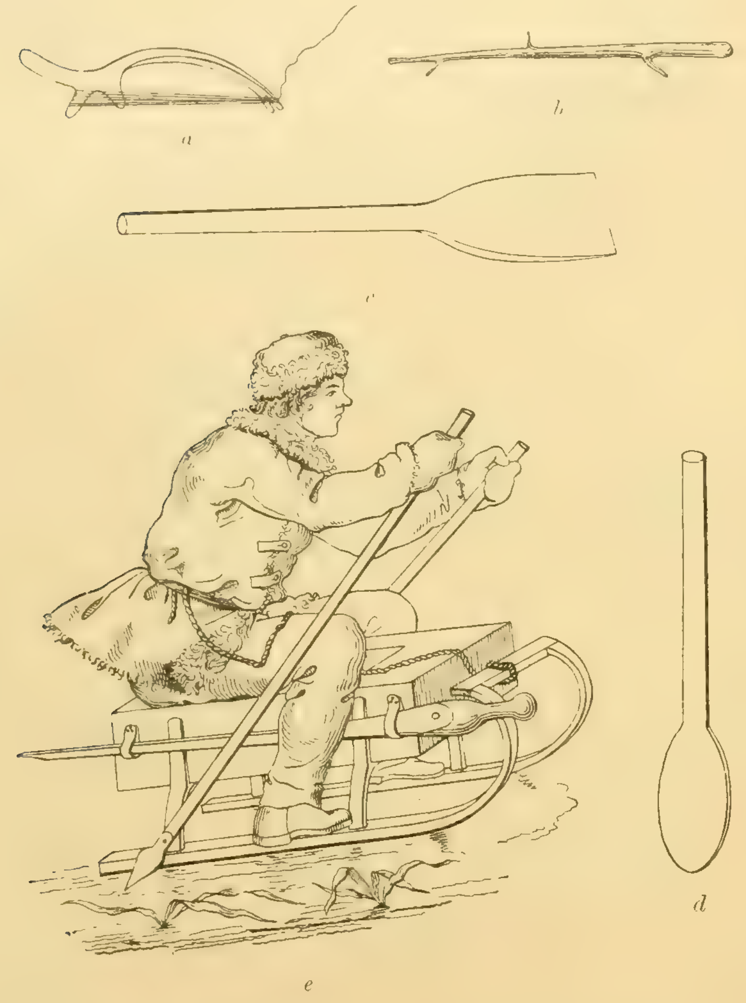


Fig. 8. Fishing-tackle used in winter; *a* and *b*: rods, *c* and *d*: ice-shovels, *e*: fishing-sled, with ice-chisel fastened at the side.

In shore-angling a ‘float-rod’ (*flötspö*) is used, in deep-water fishing a ‘feeling’ or ‘sinking’ rod (*känn-* or *sänkspö*). The angler who chooses the former mode, makes his way to steep shores, rocky points or stony headlands, and must content himself with the smaller fish which swim near shore. If he fishes in a boat or coble, he generally makes his craft fast at the edge of the reeds by grasping a handful of them and either sitting on it or twisting it round a thole. It is only with difficulty that he can use more than one rod, as he is bound to take great care that the hook does not catch in weed or rubbish, in which case it must be disentangled by the help of a withe, a ring or something of the kind. In deep-water fishing the angler prevents his boat or coble from drifting by means of a cord fastened to a large stone or a grapnel. From three to five rods are used, the number varying according to the skill of the fisherman. In order to be able to attend to them all, he sits in the middle of the boat with his face towards the bow, and on one or two boards laid across the boat he arranges one rod, sometimes two, on each side, and casts the third or fifth out over the bows.

Winter-angling (fig. 8), though seldom remunerative in comparison with the trouble that must be taken, is still considered by many to be good sport. The ordinary season for it is the beginning of winter before the ice is too thick, and towards spring when the days begin to grow warmer. The necessary tackle is composed of a short, curved rod (*metträ*) with hook and line, a small ice-chisel (*isbill*) for cutting holes in the ice, a shovel to keep the holes clear, and lastly a fishing-sled or simply a creel to contain the fish as well as the rest of the tackle, and also to serve as a seat for the fisherman. The success of this mode of fishing greatly depends upon the fisherman’s knowledge of the spots where the Perch has its winter haunts. These are generally at the edge of the deep water in the creeks or off steep shores and headlands. The fisherman makes his way to a spot of this kind, cuts a small hole in the ice, and when he has cleared away all the loose bits of ice from the hole, lets down the hook to the bottom and takes in so much line that the hook hangs from 4 to 6 inches from the bottom. He then sits down on the sled or the creel and keeps moving his hand

(Sw. *leker* = plays) in a manner impossible to describe exactly, in order to give the hook a certain motion which entices the Perch to bite. When a fish bites, it is landed by winding in the line between the ice-shovel and the rod, the former being held in the fisherman's right hand and the latter in his left. To bait the hook he makes use of a bit of bacon as large as a pea, or the eye of a Perch just caught; the hook may also be a so-called 'bright hook' (Sw. *blankkrok*) and without any bait at all. This hook should be of the right shape, and must be kept bright. The fisherman looks for the fish in the following way: he tries a hole here and there, each hole being from 10 to 13 yards away from the others, until he finds one or more fish in a hole. Then he begins to try holes close to the same spot, sometimes not more than two yards apart. We may see how little the Perch moves about at this season, from the fact that the fisherman often takes several in one hole, but does not get a single bite in another close by.

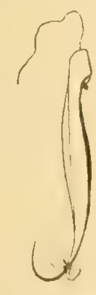


Fig. 9. 'Bright hook'.

The 'slinging rod' (*stimspö*) may be employed with a fair amount of success. This must be in summer, however, the season when the Perch collects in shoals; and the best time of day is from 6 p. m. till sunset. The day should be calm and warm. The angler must have a boatman with him, and should be rowed out to the reefs in the bights of the lake where the Perch has taken up its abode. When the shoal approaches, the hook should be cast and trailed along the surface of the water. The boatman should be skilful enough to steer the coble after the shoal without any noise or splashing. The bait should consist of a bit of dried eel-skin (Sw. *stimlapp*) cut in the shape of a bleak or a smelt, or a triangular strip of skin cut from the belly of a Perch.

Another mode of fishing is practised in some places. The tackle employed is known as 'striking hook' (Sw. *huggkrok*, fig. 10). The autumn, beginning at the middle or the end of August, is the only season for this fishing, and the spot selected should be in shallow water, or near shore and close to the edge of the reeds, where the water is fairly deep. The tackle used consists of a piece of lead about 3 inches long and shaped like a fish, on each side of which is a large steel hook. The angler should be alone in his boat, and when he has reached the place where he intends to fish, he keeps the boat still by plying his oars in a certain way: he holds them with his left hand, while with his right he drops the hook to the bottom and quickly jerks it up again as soon as it has sunk. The Perch, mistaking the piece of lead for a real fish, darts forward to seize it and is caught on the point of one of the steel hooks. As soon as the fisherman feels that he has struck a Perch, he must drop his oars without a moment's delay and draw up the fish into the boat. He should never slacken the line, for then the fish may easily slip off the hook.

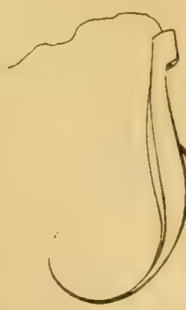


Fig. 10. 'Striking hook'.

Another mode of fishing, suggested by the voracity and greediness of the Perch, is the night-line (Sw. *långref* = long line). The season for this is the same as that for angling. When setting the line, one should remember that if it is to be set only for Perch, it ought not to be placed in deep water, but nearer shore, around rocks or shoals, etc. Small fry or lobworms are used as bait, and in baiting the hooks one should follow the advice already given under the head of angling. The line should not be set before sunset, so that the bait may not be eaten by small fishes, which swim about in the water during the daytime. It should not be left unexamined until late in the day, for in that case a number of fish manage to escape, and others die and thus lose flavour. In order to facilitate the setting of the line, when dead bait is used, a box (Sw. *reflåda*) is employed, in which the line is placed ready for setting and measured in fathoms. Every three or four fathoms a loop with a hook ready baited attached to it is fastened to the line. The upper edge of the box has a number of notches cut in it, into which the hooks are inserted. When the line is to be examined, it is only lifted up from the bottom of the water, the hooks, from which the bait has been taken, are baited afresh, and those on which a fish is found, are unfastened and other hooks set in their place. When the line is taken up, it is coiled in the box and the hooks are placed in the notches. When the line is examined or taken up, the fisherman must have a small landing-net ready, in which to lift the fish out of the water and get them into the boat. Some persons use a gaff for this purpose, which they strike into the belly or gills of the fish, and then lift it out of the water. This method is, however, not so sure as the former. The line must be examined daily, and ought not to be left in the water more than three or four days without being taken up and dried.

In his 'Travels in Westergotland' (1746, p. 259) LINNÆUS gives a description of some perch-fishing in Lake Yngen in Wermland in which the tackle consisted of a circular net two yards in diameter. "The Perch always keeps close to the crags or rocks in the lake. Thither the fisherman rows and drops the net to the bottom, whereupon the Perch, which are always fond of rings and circles, begin to sport in crowds above it. When the net is drawn up, the Perch becomes frightened, darts towards the bottom and is thus taken in the net, often in considerable numbers."

The Perch is also often caught by nearly all sorts of fishing-tackle set near its haunts for other fish. Thus large Perch are often taken by trolling, on a hook drawn along the surface of the water (*dragkrok*) and on a line fastened to a pole which is fixed in the bank (*stångkrok*). In the autumn too it is often struck with a gig.

Besides the culinary value of the Perch, its usefulness in other ways deserves mention. It is a fact well known from the earliest times that, by boiling, an excellent glue may be extracted from its skin. In several places in Sweden the scales are used in making all sorts of personal ornaments, being arranged in the shape of leaves and flowers for bracelets, necklaces, earrings and ornaments for the hair. As the Perch is of such common occurrence, it is a comparatively cheap fish. In spring the average price of a middle-sized, live Perch in Stockholm is from $2^1/_4$ d. to $3^1/_4$ d.; at midsummer it is scarcer and the price higher, in autumn the price sometimes rises as high as $5^1/_4$ d. and during winter it is sometimes as much as $6^3/_4$ d. (EKSTRÖM, SMITT.)

GENUS **STIZOSTEDIUM**[a].

Body oblong. Scales small with the margin sharply dentated. Preoperculum and shoulder-girdle serrated (inferior margin of the preorbital bones even). Cheeks scaly, scattered scales on the occiput. Teeth set in one row (sometimes irregularly in 2 or 3) on the intermaxillaries, the lower jaw and the palatines, with scattered canine teeth largest on the anterior part of these bones. A transverse row of cardiform teeth (often disappearing in older specimens) on the vomer. Tongue without teeth. From 3 to 7 pyloric appendages. Pseudobranchiæ complete. Branchial membranes separate with 7 rays on each. From 13 to 16 rays in the first dorsal fin. In the anal fin 2 spinous rays; the base shorter than that of the second dorsal fin. In the caudal fin 15 branched rays.

Of this genus there are assumed to be 2 distinct species from the Eastern Hemisphere and 2 from the Western, and the difference between the types of the Old and New Worlds is greater in this case than in the genus *Perca*.

THE PIKE-PERCH (SW. GÔS).

STIZOSTEDIUM LUCIOPERCA.

Plate III, fig. 2.

The posterior upper corner of the gill-cover without spines (in older specimens), but two or three dentations on the margin. The colour of the body grayish green, becoming lighter towards the belly, where it is silver-white, darker towards the back, where there are about 12 transverse black stripes.

R. br. 7: *D.* $15^b \frac{1^c}{1+21}$; *A.* $\frac{2}{12^d}$; *P.* $2+12+2^e$; *V.* $\frac{1}{5}$;
C. $x+15+x$; *L. lat.* 88–92^f.

Syn. Lucioperca, Schilus et Nagemulus Auctorum, ART., *Gen.*, p. 39; *Syn.*, p. 67; *Spec.*, p. 76.

Perca Lucioperca, LIN., *Syst. Nat.*, X, Tom. I, p. 289; RETZ. *Fn. Suec. Lin.*, p. 336; NILSS., *Prodr.* p. 82; EKSTR. *Mörkö Fisk.*, Vet.-Akad. Handl. 1831, p. 89; REUT. et SUNDM., (*Lucioperca*) *Finl. fiskar*, 1, p. 9, tab. III.

Lucioperca sandra, CUV., VAL., *Hist. Nat. Poiss.*, II, p. 110, tab. 15; KRØYER, *Danm. Fiske*, I, p. 32; NILSS., *Sk. Fn.*,

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[a] SCHM. RAFINESQUE, Ichth. Oh.: vide JORD. GILB., l. c.

[b] Sometimes 14 (or 13, according to KRØYER).

[c] $\frac{2}{1+20}$ l. $\frac{2}{1+21}$, i. e. 2 spinous rays and 21 or 22 soft, the first of which is not branched.

[d] $\frac{2}{1+11}$ l. $\frac{2}{1+12}$.

[e] 2 + 11 + 2 l. 2 + 13 l. 1 + 13 + 2 l. 2 + 13 + 1 (Vid. note *h*, p. 26).

[f] Number of rows of scales parallel to the lateral line from 100 (in small specimens) to 150 (in large).

Fisk., p. 22; Heck., Kn., *Süsswasserf. Œsterr.*, p. 8; Gthr., *Brit. Mus. Cat., Fish.*, I, p. 75; Winth., Naturh. Tidskr. Kbhvn 1879, p. 7; Fedders., ibid., p. 72; Lillj., *Sv., Norg. Fiskar*, I, p. 59.

Var. 1. spec. dist.?: squam. corp., coec. pyl., rad. pinn. an. paucioribus.

Perca volgensis, Pall., *It.*, I, p. 461; Cuv., Val., l. c. p. 117 et vol. VII, p. 441; Nordm., *Demid. Voy. Russ. Mér.*, III, p. 363, tab. 1, fig. 2; Heck., Kn., l. c., p. 12; Gthr., l. c., p. 74.

Forma americana: operc. acul.

Var. 1. spec. dist.?: squam. corp. et coec. pyl. plur.; rad. pinn. an. paucior.

Lucioperca canadensis Sm. in Griff. *Cuv. Anim. Kingd.*, X. p. 275; Jord. et Gilb. (*Stizostedium*), *Syn. N. Amer. Fish.*, Bull. U. S. Nat. Mus., N:r 16, p. 526.

Lucioperca grisea, De Kay *N. Y. Fn., Fish.* p 19, tab. 68, fig. 221 (*canadensis*); Gthr., l. c. p. 76.

Var. 1. spec. dist.?: squam. corp. et coec., pyl. paucioribus: rad. pinn. an. plur.

Perca vitrea, Mitch., Suppl. Amer. Monthl. Mag., II, p. 247 Jord. et Gilb. (*Stizostedium*) l. c., p. 525.

Perca salmonea, Rafin, Amer. Monthl. Mag. V. p. 354. (sec. Jord., Gilb.).

Lucioperca americana, Cuv., Val., l. c., II, p. 122.

Lucioperca lucioperca, Kirtland, *Rep. Zool. Ohio*, p. 190, (sec. De Kay).

Obs. The list of synonyms for both the species of Pike-perch on each side of the Atlantic, which have hitherto been universally acknowledged, is intended to prepare the way for a new treatment of the question as to their natural relationship to each other. Both in the Old World and the New the number of pyloric appendages varies from 3 to 6 or 7. Our Pike-perch generally has 6, but I have sometimes found only 5; Cuvier and Krøyer speak of only 4. Jordan and Gilbert state that the variation in *Stizostedium canadense* is between 4 and 7. In conjunction with the least number of these appendages (3) on both sides of the Atlantic there appear a smaller number of (larger) scales on the body, and a deeper (less elongated) form[a]. In addition to these three variations there is, according to most authors, a difference in the number of rays in the anal fin. Here, however, the case is reversed, for in the Old World the greatest number of rays in this fin is a character of the variety with small scales, while in the New it belongs to the large-scaled variety. The last named difference is, however, according to Jordan and Gilbert, not universal. The importance of these differences may be variously estimated, either as constituting a distinction of species or only of variety. The analogy in their tendency in both continents is highly remarkable. If we disregard the difference in colour — the American Pike-perch being without the transverse black bands on the back and the sides being more like brass in colour or having distinctly marked longitudinal lines, running in an oblique direction, of brass-coloured spots —, the only essential difference in form between the American Pike-perch and the European that has hitherto been observed is in the armour of the gill-cover. In two specimens of *Stizostedium vitreum*, the one 167 mm. in length and the other 471 mm., which the Royal Museum has acquired through the Smithsonian Institution, the smaller specimen being from Pekin, Illinois and the larger from Lake Michigan, the surface of the gill-cover has a longitudinal bar on the upper part which reminds one of the bar in *Acerina* or *Polyprion*, though it is much less developed. This bar is continued by a flat spine at the posterior upper corner of the gill-cover. In *St. lucioperca* both bar and spine are wanting in older specimens, though the corner of the gill-cover is furnished with 2 or 3 dentations in the margin which remind one of it. But we can generally find a trace of the bar in older specimens, and in smaller specimens (between 200 & 300 mm. long) it is usually still clearer, while these specimens sometimes have a distinct, flat spine at the corner of the gill-cover. The difference in this respect is therefore due to the fact that the American Pike-perch has retained a juvenile character which disappears in the European. To judge by the specimens now before us, *St. vitreum* has several other points of resemblance to *St. lucioperca*. The longitudinal diameter of the eye in the specimen of *St. vitreum* from Lake Michigan which is mentioned above, is 17 % of the length of the head, and in specimens of *St. lucioperca* of the same size from 14.4 % to 14.7 %. But in smaller specimens of the latter species, about 270 mm. long, the ratio is from 16 % to 17.5 %. The case seems to be the same with the only constant distinction between the two species that we have been able to discover, namely the comparatively greater length of the suboperculum in *St. vitreum*. In adult specimens of the European Pike-perch, even those only 270 mm. long, the least depth of the tail is equal to the length of the suboperculum (measured along the middle to the end of the dermal flap), but in smaller specimens 180 mm. in length, I have found the least depth of the tail to be only 88 % of the length of the suboperculum. In the smaller specimen of *St. vitreum* the ratio is 72 %, while in the larger one it is 74 %, a fact which may suggest the opinion that in this variety too it increases with age. Lastly, in order to prove that the structure of the fins, at least in the two specimens of the American variety which are all I have to judge by, rather strengthens than weakens our point that *St. lucioperca* and *St. vitreum* belong to one and the same species, the fin formula for the larger specimen is given below:

$$R.\ br.\ 7;\ D.^{b}\ 16\,\frac{1}{2+17};\ A.\ \frac{1}{2+12};\ P.\ 2+11+2;\ V.\ \frac{1}{5};\ C.\ x+15+x;\ L.\ lat.\ 93;$$

In the smaller specimen we have $D.\ 13\,\frac{1}{2+16};\ A.\ \frac{2}{1+10}$.

Thus, as in the case of the Perch, we seem to have most ground for the adoption of only one species of Pike-perch, this species differing, however, more sharply in its local varieties, the safest character for which may perhaps prove to be the difference in colouring.

In comparison with the Perch the Pike-perch is more elongated and thicker. The greatest depth of the body is at the middle, from which point the body gradually tapers towards the head and tail. The depression in the occipital profile which marks the Perch, is generally absent in the Pike-perch. On the other hand we generally find in the latter a marked depression between the two dorsal fins. The length of the head in proportion to the length of the body[a] is about the same as in the Perch, from 26 to 28 p. c.; but the depth of the body at the insertion of the ventral fins is only equal to the distance from the tip of the snout to the hind margin of the preoperculum. The mouth is fairly large and almost horizontal; the bones of the upper jaw extend backwards to a point almost exactly above the posterior margin of the eye. The snout projects only slightly beyond the lower jaw, at the point of which there is a kind of knob. The two canine teeth in the lower jaw fit into cavities in the front of the upper jaw when the mouth is closed, while the front canine teeth on the intermaxillaries project beyond the margin of the lower jaw. There are 8 pharyngeals, and teeth on all of them, consisting of 2 lower, which are oblong in shape, and 6 upper, which are smaller and coalesce into 2 oblong and distinctly separate pharyngeals. The two nostrils, the front one being furnished with a cover, are situated nearer the eye than the snout, and the distance between them is about the same as that between the back nostril and the anterior orbital margin. The scales are stiff and sharp, and they are, as is generally the case, smaller in the anterior part of the body than in the posterior; even the cheeks (at least in the upper part and in front) are covered with scales, as well as the gill-cover and the suboperculum. On the occiput and forehead and in the depression at the middle of the head, they are of irregular occurrence. The lateral line is straight and runs nearer the back than the belly. The first dorsal fin begins vertically above the insertion of the ventral fins, the second above the vent. As in the Perch, the margin of the first is arched, while the second is straighter, but, like the anal fin, slightly rounded. In older specimens the base of the anal fin is equal to the distance between the anterior orbital margin and the hind margin of the preoperculum, or about half the length of the base of the first dorsal fin. In younger specimens it is slightly shorter. The least depth of the tail is about equal to the distance between the hind margin of the eye and that of the preoperculum. The pectoral fins are inserted in front of the vertical line from the beginning of the first dorsal fin, and the upper rays, and generally some of the lower as well, are unbranched but articulated. The length of the ventral fins is in older specimens about half the distance between their insertion and the beginning of the anal fin, or even less. In younger specimens their length is greater. The caudal fin is more forked than in the Perch.

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[a] However, in our specimen of the American *St. vitreum* as in *St. lucioperca*, the depth of the body at the insertion of the pectoral fins is equal to the distance between the tip of the snout and the hind margin of the preoperculum; and the number of transverse rows of scales along the lateral line (about 120 above it) may be included among the variations according to age in our Pike-perch.

[b] According to Jordan and Gilbert $D.\ 13\,\frac{1}{21}$, according to Günther $D.\ 14\,\frac{1}{19-21}$.

In brilliancy of colouring the Pike-perch does not stand high, and is considerably surpassed by the Perch. The back of the head is grayish black. The back is dark gray with transverse, irregular bands of black spots across it, which usually extend down the sides a little below the lateral line. The sides become lighter and lighter towards the belly, being at first bluish gray on a brass-yellow ground, then brass-yellow towards the belly, which is silver-white. The first dorsal fin is bluish with oblong black and yellowish spots arranged longitudinally upon it in 4 or 5 rows, the spots in the top rows being usually elongated into an irregular, twisted wormlike form. The second dorsal fin grayish with smaller, black and yellowish spots. The caudal fin a darker bluish gray and spotted in the same way. The pectoral fins whitish gray. The pectoral and anal fins of the same colour as the belly or dirty white with blackish gray dots. The iris silver, shading into brass-yellow and black, especially at the top. The most remarkable varieties in colouring in Sweden are a light one, which generally consists of young specimens and those which inhabit shallow water where the colour of the bottom is light, and a dark, usually including older specimens and those which live in deeper water. The transverse black bands are also sometimes broken up into separate spots with smaller spots between them.

In the large lakes throughout the greater part of Sweden[b], especially in the southern and central parts of the country (except in Lake Wetter) and with a preference for the eastern districts (though common in Lake Wener and its affluents[c] in Norway), the Pike-perch is widely spread, though in only few places especially numerous. In the island-belt within the Baltic it is one of the rarest of fishes; but still it occurs, according to the report of Mr. Limborg, the late Inspector of Fisheries, in the following places in the island-belt of Södermanland, Marsviken, where it has been introduced by the planting of eggs, the Firths of Nyköping and Sjösa, whither it has been carried by the streams which drain the neighbouring lakes, in the Firth of Sibbo, where fry have been planted, and also at the mouth of the Trosa river and a little below Södertelje. It is found in the Bay of Kiel[a], but only rarely, and it has probably migrated thither through the Eider Canal. From the lakes and lagoons of Schleswig-Holstein, however, thoughout Germany east of the Rhine, in the North of Italy, and from Finland south of the Arctic-circle[b] and the island-belt of the Gulf of Finland, it is spread over the whole of Eastern Europe as far as the Black Sea and the Caspian with their affluents. It prefers deep, clear and pure water, where the bottom is sandy or stony. On a clayey bottom where the water is turbid, it is seldom found, though LLOYD[c] and LILLJEBORG assert that it occurs in places where the bottom is of this nature, in Lakes Wener and Karsholm. "It does not remain stationary in one place," writes Mr. LIMBORG, "but wanders long distances alone. It generally keeps near the bottom, but at the approach of spring it swims nearer the surface, often quite close to the ice. After the spawning-season it keeps close inshore during a short part of the summer, then goes out into deep water and first returns to shallower water at the end of August or the beginning of September. All the winter it remains in deep water." In temperament it is sluggish, and displays so little sagacity that it has given rise to the proverb, *'as silly as a pike-perch'*. Its movements in the water are also heavy and clumsy. As soon as it feels that it is a prisoner and has made one or two unsuccessful attempts to escape, it abandons itself to despair, so completely that it is most often found floating on its back at the surface. When it is taken up from deep water, the air-bladder bursts with a sound like that of eructation, and at the same moment it dies. It is not very tenacious of life and is one of the hardest fishes to keep alive; but with care at its capture and in a suitable vessel filled with fresh water it can be conveyed long distances, as proved by its transportation from Germany to England, and from Galicia to the Rhine and Lake Constance, and also by the attemps made by Mr. TRYBOM[d], an official under the Board of Fisheries, to introduce it from Lake Oppmanna into Lake Råbelöf and Ring Lake in Scania. In voracity the Pike-perch is little surpassed by its near relative, the Perch, and in its rapacity as well as in its strongly armed jaws GESSNER who, in the sixteenth century, was the first to describe the Pike-perch, found such a close likeness to the Perch, that he gave it the name of *Lucioperca*. The food of the Pike-perch consists of small fishes, especially the Smelt, which, like itself, inhabits deep water during the greater part of the year. EKSTRÖM, however, also found insects, worms, and grass in its stomach.

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[a] Here, as throughout this work, where nothing else is remarked, the length of the body is measured from the tip of the snout to the end of the middle rays in the caudal fin.

[b] According to the reports of the Commission of Fisheries from 1881 to 1883 the Pike-perch is found in all the provinces of Sweden except Jönköping, Kronoberg, Gotland, Blekinge, Malmöhus, Halland, and Jämtland.

[c] Cf. Collett, *Norges Fiske*, l. c.

The reason for the different accounts of the spawning-season of the Pike-perch must depend on the fact that it lasts uncommonly long, which is perhaps connected with the fact that it is confined to the night-time. It begins as early as the end of April and often extends to the middle of June[e]. During this period the Pike-perch makes its way in shoals to stony reefs in open creeks or stony and sandy points along the shore[f]. It never spawns in water less than from 10 to 16 feet deep. The roe, which is light in colour and very fine in proportion to the size of the fish — so fine, in fact, that more than 300,000 eggs have been counted in one single female —, is deposited on stones and water-plants to which it adheres. It is a remarkable fact that this fish is less numerous than one might expect from the number of its eggs. "The fertilization and hatching of the eggs of the Pike-perch," says Mr. LIMBORG, the Inspector of Fisheries, in Södermanland, "labours under great difficulties, for if the female be put into the cauf before the roe is almost ready to be deposited, she dies before depositing the roe. In order to succeed in the fertilization of the roe, one must try to procure females in which the roe is so matured that it can be ejected by a slight pressure on the belly, immediately after the fish is taken out of the water." NORBÄCK recommends the moistening of the parts near the vent with some drops of the milt, in order to facilitate the depositing of the eggs. Even if the fertilization succeeds, and sometimes even after the fry have left the eggs, it may happen that the attempt finally fails[g]. The fry must, therefore, receive great attention. The planting of live specimens is less difficult, if carried out at a cool time of year when the temperature is from 41° to 50° Fahr., and provided that a too great change in the warmth of the water is avoided. Specimens two or three years old should be selected and then conveyed to such lakes as seem suited for planting[a]. It is also advisable to plant Smelt in the same water for some years previously, unless they already exist there. The Pike-perch grows quickly and attains a considerable size. In Lakes Mälar and Wener it reaches, though seldom, a weight of from 20 to 22 pounds and a length of from 3 to 4 feet. TRYBOM estimates the length of a Pike-perch one year old to be from 90 to 130 mm., two years old 220 to 260 mm., and three years old 350 to 390 mm.

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[a] Cf. MÖBIUS and HEINCKE, *Fische der Ostsee*, p. 33.

[b] Cf. MALMGREN, *Krit. Öfvers. Finl. Fiskfauna*, p. 2; and REUTER and SUNDMAN, l. c.

[c] *Anteckningar under ett tjugoårigt vistande i Skandinavien*, I, p. 14.

[d] Cf. *Några fiskodlingsforetag i Skåne, åren 1883 och 1884*. Malmöhus Läns Hushållningssällskaps Qvartalsskrift. 1884.

[e] "To this rule," writes Mr. LIMBORG, "Lake Yngaren forms a remarkable exception, for there the Pike-perch first begins to spawn when the spawning-season in all the other lakes of Södermanland is over, and the spawning-season extends to the middle of July."

[f] . . . "often in very muddy water": NORBÄCK, *Fiskevård och Fiskafvel*, p. 362. Cf. also REUTER, l. c.

[g] Mr. AMTSBERG of Stralsund had great success with the fertilization, and from the eggs deposited on *Myriophyllum* he obtained "an enormous number of fry," but the greater part of them died during the summer and only some hundreds were left alive. Vid. MAX V. D. BORNE, *Fischzucht und Fischerei*, p. 277.

The Pike-perch is taken in many ways, but generally with nets or large "*ryssjor*" (see p. 33, fig. 7). At the beginning of the spawning-season, when the nights are still dark in Sweden, the Pike-perch is taken in a drag-net, if, at the places where it spawns, the bottom is so level that a net can be drawn there. It is sometimes the custom to light bonfires on the shore at this time, in the hope that the fishes may be enticed to collect near the firelight. In other places, where a drag-net cannot be employed, the Pike-perch is taken by trawling. The nets which are used in fishing for the Pike-perch during winter, are made especially for this purpose, the meshes are large, and the nets are always set in deep water. From midsummer till late in autumn the Pike-Perch is also caught on night-lines with a bait of Smelt or Bleak. Sometimes, though very seldom, it is taken with rod and line. According to EKSTRÖM live bait is necessary, but others consider half rotten, strong smelling bait the best.

The Pike-perch is undeniably one of the most delicate Scandinavian fishes. It is eaten fresh, salted or dried, in the last case generally after being soaked in lye. In France, according to CUVIER, it is also eaten raw with oil, pepper and salt. Its flesh is white, firm, free from small bones and of excellent flavour. Still it is generally stated that if one eats Pike-perch daily, one soon becomes tired of it. The fat is said to be used among the peasantry for rubbings in cases of rheumatic pains, luxations etc. According to the time, year and the abundance or scarcity of the fish, the market-price of the Pike-perch here in Stockholm varies as follows: in spring it costs about $4^{3}/_{4}$ d. per lb., in summer $6^{3}/_{4}$ d., at midsummer sometimes as much as 10 d., in autumns and winter from $6^{3}/_{4}$ d. to 8 d., sometimes not so much. All these prices are reckoned for middle-sized and perfectly fresh Pike-perch.

(EKSTRÖM, SMITT.)

GENUS **ACERINA.**

Form of the body an oblong oval slightly compressed at the sides. Scales middle-sized with sharply dentated margin. Top of the gill-cover furnished posteriorly with one or two spines. Preoperculum and shoulder-girdle dentated. Inferior margin of the preorbital bones without teeth. Head naked, its outer bones pierced with large ducts connected with the lateral line. Small, cardiform teeth of equal size on the intermaxillaries, the lower jaw and the vomer; also in a simple row on the palatine bones (often wanting on the vomer and the last named bones). Tongue without teeth. Only three pyloric appendages. Pseudobranchiæ present but only rudimentary. Branchial membranes separate, each with 7 rays. One dorsal fin with from 13 to 19 spinous rays. Two[b] *spinous rays in the anal fin, its base shorter than the soft-rayed part of the dorsal fin. In the caudal fin 15*[c] *branched rays.*

Of this genus, which is confined exclusively to the so called Palæarctic region (Europe and Northern Asia), four species have been described, distinguished from one another by the colouring, the difference in the number of spinous rays in the dorsal fin and of the rows of scales, and the varying length of the snout. The species which possesses the shortest snout and the least number of rays in the dorsal fin is our common Pope.

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[a] Cf. TRYBOM, l. c. and the same Quarterly Report for 1885, p. 277.

[b] Rarely 3.

[c] 14.

THE POPE OR RUFF (SW. GERS.)

ACERINA CERNUA.

Plate III, fig. 3.

Eyes set about half-way along the head (length of the snout nearly equal to the distance from the posterior orbital margin to the end of the gill-cover). *Number of spinous rays in the dorsal fin 16 at most. From 36 to 40 scales in the lateral line. Colour of the body grayish or greenish brown with dark spots on the sides and the unpaired fins: the belly whitish.*

R. br. 7; *D.* $\frac{14^{a}}{12}$; *A.* $\frac{2^{b}}{6}$; *P.* $2+11+1^{c}$; *V.* $^{1}/_{5}$; *C.* $x+15+x^{d}$; *L. lat.* 36–39[e].

Syn. *Cernua, Perca minor, Aurata et Porcellus Auctorum*, ART., *Ichth.*, *Gen.*, p. 40; *Syn.*, p. 68; *Spec.*, p. 80.

Perca cernua, LIN., *Syst. Nat.*, ed. X, tom. I, p. 294; RETZ. *Fn. Su. Lin.*, p. 338; GTHR (*Acerina*), *Brit. Mus. Cat., Fish.*, I, p. 72; COLL., *Norg. Fiske*, 1874, p. 16; LJBG, *S., Norg. Fiskar*, I. p. 66.

Acerina vulgaris, CUV., VAL., *Hist. Nat. Poiss.*, III, p. 4; NILSS., *Prodr. Ichth. Sc.*, p. 78; EKSTR., Vet.-Akad. Handl. 1831, p. 96; ID. et W. v. WRIGHT, *Skand. Fiskar*, ed. 1, p. 9, tab. 1. fig. 2; KRØYER, *Danm. Fiske*, I, p. 43; NILSS. *Sk. Fn., Fisk.*, p. 28; WINTHER, *Zool. Dan., Fiske*, p. 4; FEDDERSEN, Nat. Tidskr. Kjøbenh., 1879, p. 72.

To the casual observer the Pope seems closely to resemble the Perch, and in its way of life too there is much to remind us of the latter. Its body is almost the same in shape as that of the Perch, but is more rounded, for though the dorsal edge is sharp, the belly is not so much compressed as in the Perch, a circumstance which gives the Pope an appearance of being fatter and in better condition. For this reason in some parts of Sweden the name of *skattbonden* (rich peasant) is bestowed upon it. Although the body is covered with hard scales which are firmly fixed and ctenoid (denticulated at the margin), still it does not feel rough, as it is enveloped in a thick, clammy mucus. This secretion is especially noticeable on the surface of the head, and has given rise to several provincial names by which the Pope is known, as for instance *snorgers* (*snor* = the secretion of the nose), *snorpels* (*pels* = skin), *snorluf* (*luf* = forelock, forehead) etc. The back is of a grayish brown olive-colour, and the single dorsal fin is of the same colour with a touch of yellow and is marked with dark dots, which are set in rows on the membrane between the rays. On the back too there are large, dark spots, and the sides, which are yellowish gray or brass-coloured, are marked with dots or small spots. The length of the dorsal fin, the relative length of which increases with age, is about half the length of the body. The spinous rayed part, which also increases proportionally in the same way, forms about $^{2}/_{3}$ of the fin. Both the spinous-rayed and soft-rayed parts — the depression between which recalls to mind the two separate dorsal fins in the Perch and Pike-perch — have a rounded (convex) margin; and in both of them the 4th and 5th rays are the longest. In the spinous-rayed portion the last ray is longer than the next one before it, a circumstance which indicates that the former really corresponds to the first ray in the second dorsal fin in the case of those genera of the family which have two distinct dorsal fins. The head is of the same colour as the back; it is oval and somewhat compressed, the depression on the forehead and just behind the eyes giving the snout a swollen appearance. It is fairly large in proportion to the length of the body, being from 27 to 29 % of that length. Its exterior bones are pierced by a system of ducts, the so-called muciferous ducts, which are larger in the Pope than in the Perch or the Pike-perch. These ducts comprise part of the organs of sensation connected with the lateral line, a structure peculiar to fishes and the batrachians[f]. The orifices of these ducts form, in the case of the Pope, the so-called muciferous cavities, which are lined with a membrane which freely secretes the mucus. There are three of these oval cavities on the

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[a] Sometimes $\frac{13}{12}$ l. $\frac{14}{13}$ l. $\frac{14}{11}$ l. $\frac{15}{10}$ l. $\frac{16}{10}$.

[b] Sometimes $^{2}/_{5}$. In a specimen from the island-belt off Stockholm we find $^{3}/_{6}$.

[c] Sometimes 2 + 10 + 2 l. 2 + 12 + 1 l. 1 + 12 + 1 l. 2 + 11.

[d] In a specimen from Archangel the numbers are $x + 14 + x$.

[e] 40 according to DAY, l. c.

[f] See LEYDIG, *Lehrb. d. Histologie*, p. 201 and *Festschr. z. Feier d. 100-jähr. Best. d. Naturf. Ges. z. Halle*, 1879; F. E. SCHULTZE, Arch. Mikr. Anat., VI (1870), p. 62; B. SOLGER, ibid. XVII (1879), p. 95 and 458, XVIII (1880), p. 364, with the passages on this subject which are there quoted.

forehead, one on each side of either nostril. One row of cavities runs along the cheek, and another on the margin of the preoperculum is continued along the lower jaw. In front of all, on each side of the tip of the snout, is a little, round hole through which the system of ducts has free communication with the surrounding water. The operculum and preoperculum, as well as the shoulder-girdle (the post-temporal and clavicular bones) are armed with spines. The mouth is of average size, and the upper jaw projects slightly over the lower. There are several rows of very fine and closely set teeth on the jaws and the anterior portion of the palate, and also 4 pharyngeal patches of teeth, 2 upper and 2 lower. The nasal sacs are fairly elongated and are situated about halfway between the tip of the snout and the anterior orbital margin. The anterior nostril is tubular and round and is furnished with a membranous flap, the posterior is larger and oval and is without a cover. The eyes are fairly large, their longitudinal diameter is in older specimens 24 or 25 % of the length of the head, in younger about 29 %. In the former this diameter is equal to the distance between both the posterior nostrils, in the latter greater than it. The iris is yellow, the lens blue. When the fish has been out of the water for some time, however, the lens turns a whitish blue-green, something like the appearance known as wall-eye. The lateral line is near the back and follows its curve. In the anterior portion of the body it pierces the scales obliquely downwards in a longitudinal direction, so that the anterior scales in this line are dentated at the posterior margin only above the ducts of the lateral line, and are also posteriorly emarginate. Nearer the tail the ducts of the lateral line pierce the scales nearer their centre and follow their direction exactly, so that the hind margin is dentated both above and below the incision we have just mentioned. The belly is yellowish white and flat, as is also the breast, which is silver-white but shifts in colour like mother of pearl at the death of the fish and finally becomes rose-red. In the dorsal fin there are from 25 to 27 rays, and of these the posterior ones, from 10 to 13 in number, are soft and branched, while the rest are strong and pungent spinous rays. In the pectoral fins there are, as a rule, 14 or 15 rays, and of these the two highest, and generally the two lowest as well, are undivided but articulated. In colour these fins are grayish yellow with fine, dark dots forming transverse bands. The ventral fins are almost white and without spots. The anal fin resembles the ventral fins in colour or sometimes has just a few dark spots upon it. As a rule, it contains only 2 spinous rays, and, a strange exception to the general rule, the first of these is considerably longer and stronger than the other. In the specimen which has 3 spinous rays in this fin, the first is little more than half as long as the second, which is the strongest and longest. The caudal fin, which is grayish yellow with dark spots arranged in transverse bands, is deeply forked.

The internal organs of this fish are very like those of the Perch, with the exception of the fact that in the female the roe-sac is double, though its parts are united posteriorly. The number of the vertebrae is 37 and of the ribs 15.

We know just as little of any constant, external distinction between the sexes in the Pope as in the Perch and Pike-perch, but difference of age involves considerable changes in form, and some of the most important of these may be traced in the following table:

		Acerina cernua from		
	Siljan ♀	Hudiksvallsfjärd ♂	Islands near Stockholm[a] ♀	Mörkö ♀
Length of the body from the tip of the snout to the end of the middle rays of the caudal fin ... mm.	83	137	142	167
Length of the head ... in % of the length of the body	28,9	27	28,9	27,5
Longitudinal diameter of the eye ... »	8,4	6,6	7,4	6,6
Base of the dorsal fin ... »	45,8	48,2	50,7	51,5
Spinous-rayed portion of the dorsal fin ... »	28,9	31,4	35,2	33,5
Base of the anal fin ... »	10	11,7	13,4	12,3
Distance between the insertion of the ventral fins and the beginning of the anal fin ... »	28,9	31,4	31,3	32,3
Length of the ventral fins ... »	16,9	19	17,6	18,5
Greatest depth of body ... »	21,7	27	27,4	27
Least » » »	7	8	8,4	7,8

[a] In this specimen we find $D.\ \frac{16}{10}$ and $A.\ \frac{3}{6}$, as well as a number of juvenile characters, e. g. the exceptional size of the head and of the eyes.

Thus the length of the head and the size of the eyes in proportion to the length of the body diminish with age. The other proportions given above increase with age; and the male seems to differ from the female in the greater length of the ventral fins and the slightly deeper form of the body.

The Pope, which in Scandinavia is known by several names, e. g. *kullbas* or *kullribas* (the German *Kaulbarsch*) in the south of Sweden, *Hork* in Denmark and *Horr* in Norway, occurs more or less plentifully in almost all waters. It seems, however, to belong more strictly to the central and northern provinces of Sweden than to the southern ones. With the exception of the countries which border on the Mediterranean, it occurs throughout Europe, and in the Arctic regions it is met with from the White Sea to Siberia, at least as far as the Lena. It inhabits the island-belts of the Baltic where the water is not too salt, as well as most of our rivers and lakes. It prefers lakes where the water is clear, and though it is sometimes met with in lakes with a muddy bottom, still it does not flourish so well in such waters. It apparently prefers a bottom of sand or clay, but may also be found where the bottom is stony or among weeds. In spring it ascends the streams and brooks, but does not stay there during winter. In autumn it makes its way to deep water, where it passes the winter. It seems to be of a very sluggish disposition. It always keeps close to the bottom, never goes to the surface and is seldom seen midway in the water. During the spawning season and in winter it lives in company with its fellows,[a] while during the rest of the year it leads a solitary life. It stays long at the same spot and seems to await the approach of its prey rather than hunt for it; and when it does move, it does not do so by continuous swimming but by rapidly darting forward again and again. Still it is not incapacity that is the cause of this sluggishness and indifference. When it is frightened, its movements through the water are so speedy, that they have given rise to the proverb 'as quick as a pope'. Its voracity is great, and it eats indiscriminately small fry, insects, worms and shellfish, which it finds on weeds, stones or other objects lying in the water. Seldom, if ever, does it seize any prey which is at liberty and moves quickly through the water. Thus it bites freely if the bait be allowed to rest at the bottom. It is highly tenacious of life[b], is thought to be slow of growth[c] and does not reach any considerable size. In one or two lakes, according to report, it may become as large as a middling-sized perch. In the island-belt off the east of Sweden it never attains a greater length than 200 mm.

The spawning-season lasts long and occurs at about the same time as that of the Perch, i. e. with us in May, but earlier to the South. It spawns in moderately deep water where the bottom is of sand or clay and overgrown with sedge. The roe is fine and yellowish, and is deposited among the sedge or on the sand at the bottom. It is very prolific; in one roe, which weighed about 11 grams, Bloch counted 75,600 eggs.

In Sweden the Pope is one of the fishes not held in high esteem, and there is therefore no special mode of fishing for it. In certain places, however, it is taken both in nets and in seines. When it lives alone, it is taken on almost every kind of tackle, together with other fishes; thus it is often caught by the perch-fisher when the bait is allowed to sink fairly deep. In Sweden it is only the peasants and poor people who know the value of the flesh of the Pope, which is firm, white, of good flavour, easy of digestion and free from small bones. The peasant calls the Pope 'food for a king' (*kungamat*), but it seldom appears on the tables of the rich. As bait for pike, burbot, etc., for all its tenacity of life, it is of very little use on account of its sluggishness.

Attempt has been made to blacken the character of this undeservedly despised fish still further and to add hatred to contempt, by the statement that it is guilty of devouring the roe of other fishes and small fry. These accusations are perhaps unfounded, at any rate they are not justified. The generality of fishermen believe that it frightens away all other fishes. This supposition may depend upon the circumstance that, when all other fishes, at the approach of a storm or from some other cause, withdraw from the shore to deep water, the Pope on account of its heedlessness and indifference remains and thus becomes the fisherman's only prize. It is a troublesome catch in the net, as in its struggles it becomes very tightly entangled in the meshes, and the fisherman finds great difficulty in freeing it without pricking his fingers with the sharp spines of its fins and gill-cover.

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[a] Klein relates (see Bloch, *Naturg. Fische Deutschl.*, II, p. 75) that at one haul of a winter seine in Frische-Haff an enormous quantity of pope and salmon-fry were taken: he declares that there were about 780 barrels.

[b] According to Flemming (see Bloch, ibid., p. 77) it may be frozen stiff immediately upon its capture, and will still return to life if placed in cold water.

[c] Krøyer (*Danm. Fiske*, I, p. 54) found that in the middle of September young specimens, which were thus about 4 months old, were from $1\frac{1}{2}$ to 2 inches long.

Its enemies are sufficiently numerous. In addition to the dangers it runs at the hand of man, though a fish of prey itself, it often falls a prey to larger fishes and waterfowl.

(Ekström, Smitt.)

Genus ROCCUS[a].

Form of the body oblong and compressed. Scales of average size and dentated. Two flat spines behind the top of the gill-cover. Preoperculum and shoulder-girdle dentated. Inferior margin of the preorbital bone smooth. Head covered with scales, except the snout and lower jaw. Cardiform teeth of equal size on the intermaxillary and maxillary bones, the vomer, the palatine bones and the tongue. Pyloric appendages 4 or 5. Pseudobranchiæ well developed. Branchiostegal membranes separate, each with 7[b] rays. Dorsal fins separate or nearly so, the first containing 9 rays. In the anal fin 3 spinous rays; its base shorter than the soft-rayed part of the dorsal. Caudal fin with 15[c] branched rays.

The European Sea-perch is the representative of a genus which is most highly developed in form in North America, where its characters are still more marked and it lives in the same way as the Salmon, ascending the rivers to spawn or even landlocked in fresh water. The American species also show how closely this genus is related to the family of the Sparidae —: by the greater size of the scales, the deeper form of the body, the greater breadth (depth) of the preorbital bones and the increased fineness of the serration of the preoperculum, which almost disappears along the inferior margin of this bone — and some of these American species (the sub-genus *Morone*[d]) are of special importance in explaining the relationship between the *Perch* and the *Pope*, two genera so sharply distinct from other points of view. Here, within the limits of one genus, we have those characters combined, which separate *Acerina* from *Perca*. In *Roccus* (*Morone*) *interruptus* and *R.* (*M.*) *americanus* the two dorsal fins are so nearly united, i. e., the fin-membrane from the last ray of the first dorsal fin grows so high on the first ray of the second dorsal fin, that when the first fin is raised, the second also rises simultaneously; and in the anal fin the second spinous ray is the longest and strongest as in *Acerina*, when the latter, as is sometimes the case, has three spinous rays in the anal fin. Furthermore, in conjunction with these characters so like those of the Pope, the "muciferous ducts" and "muciferous cavities" (see above) of the head are almost as highly developed as in the Pope on the sides of the lower jaw, the preoperculum and the snout. This is most noticeable in *Roccus americanus*[e], somewhat less so in *R. interruptus* and still less in *Roccus* (*Lepibema*) *chrysops*, where, however, as in all the other species of *Roccus*, they may be discerned exteriorly. The most important difference between these three species of *Roccus* and the others is the deep shape of the body, the least depth of the tail being about 11 per cent of the length of the body, while in the other it is at most 9,5, at least where the length of the body is not more than 316 mm. This character with several others, to judge by the changes of growth known to us in the European Sea-perch, sets them highest on the scale of the generic development. The fourth American species, *R. lineatus,* comes nearest our Sea-perch, and in the same way seems to represent the lowest grade of development within the genus, especially in its most remarkable character, the great length of the lower jaw, which is about 15 % of the length of the body and longer than the base of the second dorsal fin, the shortness of which in this species is, as far as it goes, a token of a lower degree of development.

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[a] Mitchill *Fish. N. Y.* (1814). Cuvier called this genus *Labrax* (Cuv., Val., *Hist. Nat. Poiss.*, II, p. 55) though he must have known and observed that this name had already been employed by Pallas to denote a genus of another family. *Roccus* is a barbarous Latinization of the American '*Rock-fish*'.

[b] Rarely 6 or 8.

[c] Rarely 13.

[d] Gill, cf. Jordan and Gilbert, *Syn. Fish. N. Amer.*, l. c., p. 530.

[e] Cf. Günther, *Brit. Mus. Cat., Fish.*, I. p. 66.

THE SEA-PERCH (SW. HAFSABORREN).

ROCCUS LABRAX.

Fig. 11.

Spines on the inferior margin of preoperculum pointing forwards, and fewer but larger than those on the posterior margin. Scales on the head, at least those on the anterior part of the forehead and on the cheeks, cycloid. The shaft of the vomer without teeth.

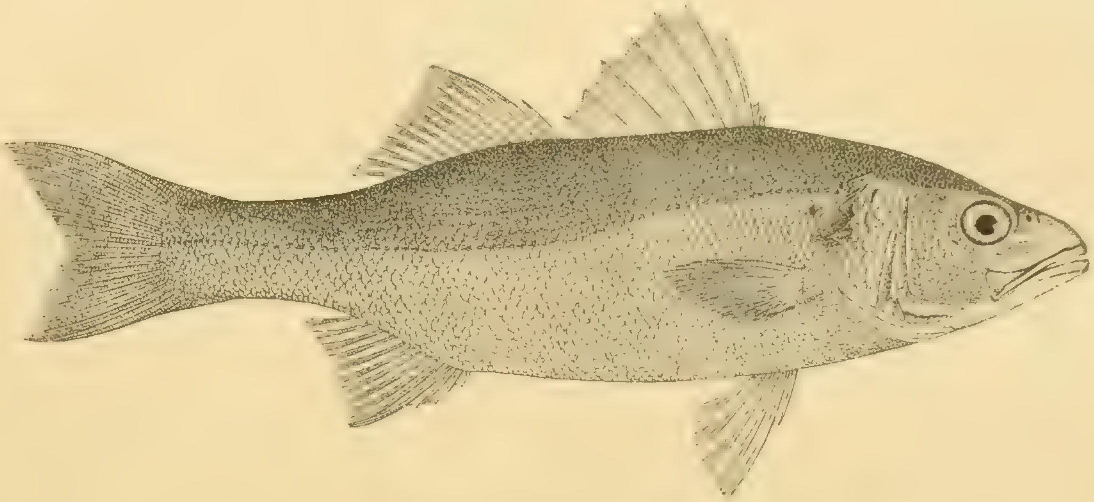

Fig. 11. *Sea-perch* (*Roccus labrax*) from Bohuslän. $\frac{1}{2}$ nat. size.

R. br. 7^a; *D.* $9\,\frac{1^b}{14}$; *A.* $\frac{3^c}{11}$; *P.* $2+15+1^d$; *V.* $\frac{1}{5}$; *C.* $x+15+x^e$; *L. lat.* $65—72^f$.

Syn. *Perca Labrax*, Lin., *Syst. Nat.*, ed. X, tom. I, p. 290; Schagerström, Vet.-Akad. Handl. 1829, p. 95, tab. III, figg. 5—7; Nilss., *Prodr. Ichth. Sc.*, p. 81; Id., *Skand. Fn. Fisk.*, p. 16.
Centropomus lupus, Lacep., *Hist. Nat. Poiss.*, IV, p. 267; Cuv., Val. (*Labrax*), *Hist. Nat. Poiss.*, II, p. 56, tab. 11; Kr., *Danm. Fiske*, I, p. 23; Gthr, *Brit. Mus. Cat., Fish.*, I, p. 63; Steind., Szber. Akad. Wiss. Wien, LVI, I (1867), p. 606; Coll., *Norg. Fiske*, p. 15; Cederström, Öfvers. Vet.-Akad. Förh. 1876, n:r 4, p. 64; Lillj., *Sv. Norg. Fn., Fisk.*, I, p. 55; Winth., Naturh. Tidskr. Kjøbenh., 1879, p. 6; Id., *Zool. Dan.*, *Fiske*, p. 3, tab. I, fig. 2.
Labrax Linnei, Malm, *Gbgs, Boh. Fn.*, p. 379.

In the colouring of its body the Sea-perch resembles the Salmon. The back is grayish black with a steel-blue lustre, the sides bright silver but this brightness tinged with a brassy yellow. The belly white. The unpaired and the pectoral fins, according to Malm, of the same grayish black colour as the back. The ventral fins of the same colour as the belly. A black spot on the upper part of the gill-cover. Blanchère[g] describes the dorsal fins as rose-coloured, the pectoral and ventral fins as yellowish. The lateral line, according to Malm, is grayish white and coasted above and below by a very fine, blackish line. During youth, according

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[a] In a specimen from Bohuslän there are only 6 branchiostegal rays. With respect to this abnormity we may point out that a specimen of *Roccus lineatus* from the Potomac has 7 rays in the left branchiostegal membrane, but 8 in the right, while a specimen of *R. americanus* from Connecticut has 7 rays in the left branchiostegal membrane and 6 in the right.

[b] Sometimes $\frac{1}{12}$ or $\frac{1}{1+12}$.

[c] Sometimes $\frac{3}{10}$ or $\frac{3}{1+10}$. Of the whole genus *Roccus* Day (*Fish. G:t Brit., Irel.*, I, p. 8) remarks: "The number of anal spines has been observed to be inconstant."

[d] Or $2+14+1$, or $2+14$, or $2+15$, or $2+16+1$.

[e] In the specimen of *R. lineatus* from the Potomac which is mentioned above, *C.* $x+13+x$.

[f] Excluding the small scales on the caudal fin which belong to the lateral line.

[g] *Dict. Gen. d. Pêches* p. 75.

to Cuvier and Steindachner, the fish generally has small black spots irregularly scattered over the body. In other respects our figure is calculated to give a correct idea of the appearance of the fish. By the character given first in our diagnosis of the species it is distinguished from the American species of the genus, and by the two last characters from *Roccus punctatus*[a], the species found in the Mediterranean, off the coasts of the Spanish Peninsula, the west coast of France and the island of Teneriffe. In southern waters it often attains a length of 1 m., but the largest specimens found in Scandinavia have been about 350 mm. in length, measured from tip of the snout to the end of the middle rays in the caudal fin.

The fame of the Sea-perch dates from the early classical times[b]. Aristotle described it and knew — among other things — that it betakes itself to the river-mouths to spawn. Archestrates calls the Sea-perch of Miletus the 'child of the gods'. For its voracity (*παρὰ τὴν λαβρότητα*) it received the name of *labrax* among the Greeks, and for the same reason the Romans called it *wolf* (*lupus*). But it was also considered a very sagacious creature. It enjoyed the reputation of being able, if enclosed in a net, to dig a hole in the sand in order to escape, and when taken on the hook, to enlarge the wound and thus get free. A fact which has been demonstrated by Americans[c] and Englishmen[d] in our own times, was also known then, namely, that the Sea-perch may be kept alive in fresh water and that when it is so kept, the delicate flavour of its flesh increases. The Romans most highly esteemed the Sea-perch which lived in the dirty water of the Tiber, between the two bridges, a taste which was long ago (in the fifteenth century) stigmatised by Rondelet as unwholesome.

The habitat of this fish is the Mediterranean with the adjoining parts of the Atlantic, as far as England and Ireland. Off the east coast of England it begins to be rare and is still rarer farther north, though, according to Collett, solitary specimens wander as high up as Tromsö. The first time it was found and recognised in Scandinavian waters, it was described by Dr. Schagerström from a specimen taken in August, 1829, off Hven in the Sound. Subsequently, to the best of our knowledge, it has been met with four times in Bohuslän.

In its way of life the Sea-perch is described as resembling on the whole the common Perch. "Sometimes," says Winther, "it lies still on the watch for its prey and sometimes wanders along the coast." The largest shoals are met with during the sardine-fishing, and in a way it does the fishermen good service, for by its pursuit of the sardines it keeps them in continual fright and confusion and thus drives them into the nets. For this reason its appearance is welcomed when the sardine-fishing is good, but when it is bad, the Sea-perch is blamed for driving the fish away. On account of its voracity it is most easily taken on the hook with a bait of sardines, shrimps, worms or something of the kind. On the south coast of England and the coast of France it is caught with a rod and line or with night-lines off the pier-heads and rocks. It is also taken in large quantities in autumn, when it comes to the mouths of the rivers or presses into the bays in order to spawn, and is then cut off at low-tide by the fishermen's nets. Almost all the year round it is taken to the markets of Paris, where it is highly esteemed for its firm, white, boneless and delicate flesh, except when it has been feasting on sardines, which give its flesh an unbearable taste of train-oil. The American *Roccus lineatus*, which in many respects closely resembles the Sea-perch, is one of the fishes most highly valued by the sportsmen of that country, even for fly-fishing[e].

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[a] Günther, Brito Capello and Steindachner, see Stzber. Akad. Wiss. Wien, LVI. I (1867) p. 607. Cf. also Moreau, *Hist. Nat. Poiss. Fr.*, II, p. 337. According to Jordan and Gilbert (l. c.) the cycloid scales on the cheeks also separate *Roccus lineatus* and *R. chrysops* from the subgenus *Morone* (see above); but in the specimen of *R. lineatus* which the Royal Museum has received from the Smithsonian Institution, this distinction does not hold good.

[b] Cf. Cuv., Val., l. c.

[c] Roosevelt, *The Game Fish*, New York 1884, p. 204 (*R. lineatus*).

[d] Day, *Fish. G:t Brit. a. Irel.*, I, p. 9.

[e] Roosevelt, l. c.

GENUS POLYPRION.

Form of the body oval and compressed. Scales small with sharp spines. The bony ridge on the outside of the operculum extending to the spine at the point of this bone, high and, like the spinous rays of the ventral fins and most of the spinous rays (the anterior at least) in the dorsal and anal fins, sharply dentated or warty (during youth at least). Preorbital bones, preoperculum, suboperculum, interoperculum and shoulder-girdle dentated. Head scaly, with the exception of the spinous or warty ridges and osseous lines of the exterior bones, and also of the lips. Villiform, in older specimens cardiform teeth on the intermaxillaries, the mandible, the vomer, the palatine bones and the tongue. Numerous (70) pyloric appendages, forming several bunches[a]. Pseudobranchiæ well developed. Branchiostegal membranes separate, each with 7[b] rays. Dorsal fin continuous, with from 10 to 12 spinous rays[c]. In the anal fin 3 spinous rays, its base being about equal in length to the base of the soft-rayed part of the dorsal. In the caudal fin 15[d] branched rays.

Of this cosmopolitan genus, which belongs to the depths of the ocean, STEINDACHNER has in recent times[e] described a new species from Juan Fernandez and the Island of St. Paul. The difference of form in this species is, however, of little importance, unless it be an indication of juvenile characters still preserved. With this exception the only species we know is the long famous

STONE-BASS OR WRECK-FISH (SW. VRAKFISKEN).

POLYPRION AMERICANUM.

Fig. 12.

Breadth of the interorbital space equal to or greater than the length of the gill-cover, sometimes equal to the least depth of the tail and from $1^1/_2$ to 2 times the longitudinal diameter of the orbit.

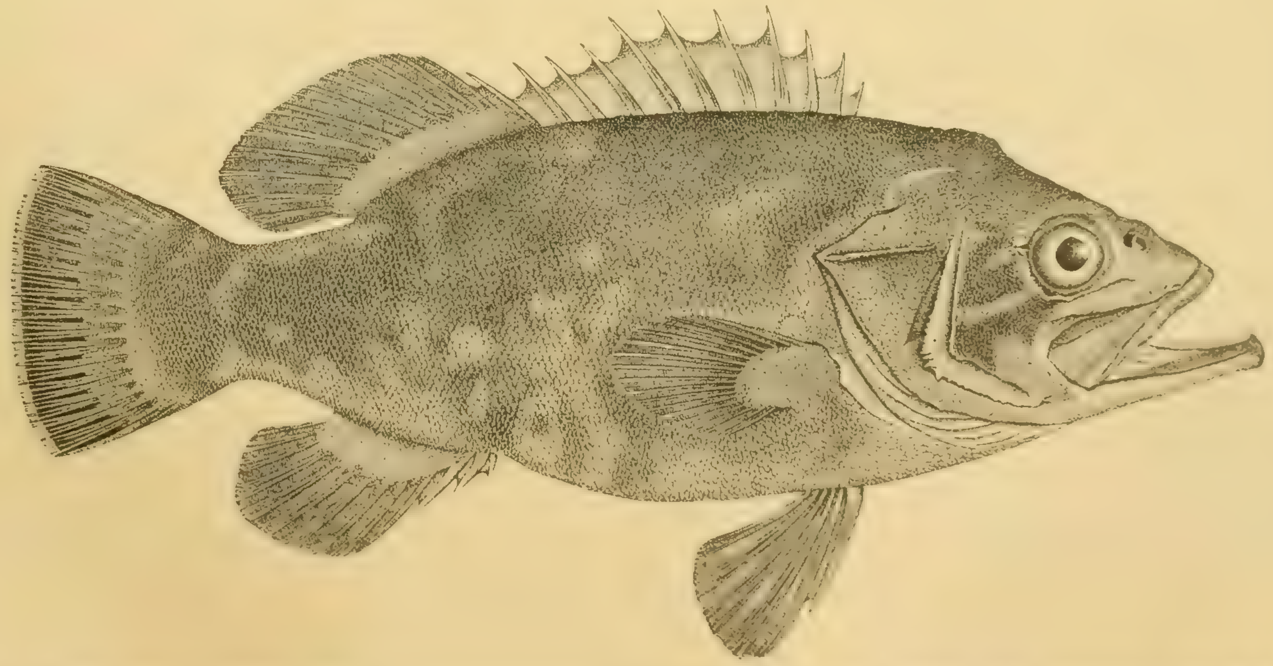

Fig. 12. *Stone-bass* (*Polyprion americanum*) from Sardinia. $^3/_5$ of the natural size. Drawn from a specimen belonging to the Zoological Museum of the University of Copenhagen.

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[a] DAY, l. c. According to GÜNTHER, l. c., there are only 2 pyloric appendages, according to MOREAU, l. c., 6.

[b] Sometimes 8.

[c] STEINDACHNER, l. c.

[d] 14, according to V. DÜBEN and KOREN, l. c.

[e] *Ichth. Beitr.*, II, 1: Sitzber. Akad. Wiss. Wien, LXXI, 1. April 1875, p. 1 (sep.).

R. br. 7[a] *D.* $\frac{11}{1 + 11}$[b]; *A.* $\frac{3}{9}$; *P.* 2 + 15 + 1[c]; *V.* $\frac{1}{5}$; *C.* $x + 15 + x$[d]; *L. lat.* circ. 90; *Squ. lat.* circ. 120.

Syn. *Amphiprion americanus*, Bloch, *Syst. Ichth.*, edit. Schneider, p. 205, tab. 47 (*A. australe*).

Epinephelus oxygeneios, Id., ibid. p. 301; Jordan et Gilbert (*Polyprion*), *Syn. Fish. N. Amer.*, Bull. U. S. Nat. Mus. N:r 16, p. 532.

Polyprion cernium, Val., Mém. Mus. d'Hist. Nat., vol. XI, p. 265, tab. 17; v. Düben et Koren, Vet.-Akad. Handl. 1844, p. 29; Nilss. *Skand. Fn., Fisk.*, p. 33; Gthr, *Brit. Mus. Cat., Fish.*, I, p. 169; Day, *Fish. G:t Brit., Irel.*, I, p. 17, tab. VI; Lillj., *Sv., Norg. Fn., Fisk.*, I, p. 71; Moreau, *Hist. Nat. Poiss. Fr.*, vol. II, p. 349.

The Stone-bass attains a length of over 6 feet. "The form of the body somewhat resembles that of the Tench," says Nilsson; and the Stone-bass really does remind one of that fish, but perhaps not so much by its shape as by the large number and small size of its scales, as well as by its colouring, at least as it appears when preserved in spirits in the museums. The most remarkable point, however, in the appearance of the Stone-bass is the roughness of its head. This is caused not only by the bony ridge on the gill-cover, which is the most important character of the genus *Polyprion*, but also by a number of similar structures on the occiput and forehead. On the neck there is a longitudinal, bony ridge, which in young specimens is serrated ('like a segment of a circular saw': Moreau), in older ones more or less smooth. In youth the epiotic bones (ossa mastoidea) have also a similar appearance, and the pterotic bones (ossa squamosa) form a straight, horizontal, bony ridge on each side, thus forming the upper boundary of the cheeks behind the eyes. On each side of the supraorbital region is a triangular or semicircular patch of radiating lines of bone, which are spinous and converge to a centre, which touches that of another radiating system of flatter bony ridges, which form a fan-shaped figure and run towards the longitudinal ridge on the occiput which we have just mentioned. The strange appearance of the fish is further enhanced in a high degree by the extent of its scaly armour, which is continued over the insertions of the pectoral and caudal fins, and also over the bases of the anal fin and of the soft-rayed part of the dorsal. In the dorsal fin we see, as in the case of *Acerina*, that the last spinous ray is longer than the one next before it; but in the Stone-bass the spinous-rayed part is lower than the soft-rayed. The hind margin of the caudal fin is rounded, but in both the specimens which I have been enabled to examine by the liberality of the Copenhagen Museum, the rays of this fin are broken off short. The colour of these specimens, which are preserved in spirits, is reddish brown, flame-coloured on the sides and almost white on the belly. v. Düben and Koren describe a freshly-caught specimen as being bluish gray on the back, while on the sides the colouring shades off into yellowish gray with a silver lustre, and on the belly becomes still lighter. All the fins were blue-black, with the exception of the ventrals, the rays of which were bluish white and the membrane blue-black. According to their description, the iris is silver and the pupil blue-black.

The Stone-bass, to which Lilljeborg has given a Swedish name formed on the analogy of the English 'Wreck-fish', a name due to the fact that it is often met with near drifting wreckage and timber, has been observed in the most distant parts of the ocean, both in the Atlantic and the Pacific Hemispheres. This circumstance seems to confirm Sv. Lovén's theory of the uniformity of the deep-sea fauna, unless *Polyprion Knerii*, described by Steindachner, be a species peculiar to the Pacific and Indian Oceans and there represent the genus. In the depths of the Mediterranean it is common, and in Southern Europe it is highly esteemed on account of the delicacy and fine flavour of its flesh. Off the coast of Scandinavia it has been met with, in the month of July, 1843, when a specimen 300 mm. long was taken on a night-line at Solsvig, about 13 miles from Bergen. Though a deep-sea fish, the Stone-bass sometimes comes to the surface, in pursuit of small fry or perhaps to spawn, and it is under these circumstances that it is most often found near floating objects covered with barnacles (*Lepades*), which do not, however, seem to form its food.

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[a] A specimen about 210 mm. long has 7 branchiostegal rays on the right side and 8 on the left.

[b] Sometimes D. $\frac{10}{1 + 12}$ or $\frac{11}{1 + 10}$.

[c] Or 2 + 14 + 1 or 2 + 15.

[d] $x + 14 + x$ according to v. Düben and Koren, l. c.

FAMILY SCLÆNIDÆ.

External bones of the head smooth, or the preoperculum and operculum slightly denticulated. Scales slightly denticulated and extending more or less over the vertical fins. When there are two dorsal fins, the anterior, which is slightly spinous, is shorter than the posterior, soft-rayed fin; when the dorsal fins are united into one continuous fin, the same relation holds good between the spinous-rayed and soft-rayed parts of this fin. The muciferous ducts belonging to the system of the lateral line very much developed in the bones of the head. Simple, conical teeth on the jaws, but the palate and tongue without teeth. Ventral fins thoracic, with one spinous and five soft rays.

As GÜNTHER[a] has already observed, the system of the lateral line in its extension on the head in these fishes follows the same typical arrangement as in the rest of the Acanthopterygians; it is only its high degree of development[b] that, to some extent, may form a character of the family, though in *Acerina* and *Roccus* we find these sensory organs but very slightly less developed. Connected with the continuation of the scales over some or all of the vertical fins, a character very common among the *Sciænidæ*, by which they range themselves along with the *Squamipinnes*, we find the continuation of the lateral line over the caudal fin, sometimes right to the hind margin. Another organ which is generally very highly developed in the *Sciænidæ*, is the air-bladder[c], which, by its longitudinal division or its appendages in the form of longitudinal tubes or transverse, simple or complex excrescences, is probably connected with the power which these fishes possess of producing sounds audible at some distance[d].

In form of body these fishes are not very unlike the Percoid family. The *Sciænidæ* might be considered as Sea-perches with, as a rule, weaker fin-rays and scales and also without palatine teeth, did not the dental equipment of two North American genera (*Haploidonotus* and *Pogonias*) call for special notice on account of the strength of the pharyngeals, which is further increased by the coalescence of the inferior pharyngeals, else a character proper to the true Pharyngognates. This form of the pharyngeal dentition — obtuse grinding teeth (molars) arranged like the stones of a pavement — reappears in the jaw-teeth of the fishes belonging to the *Sparidæ*. Another likeness between certain *Sciænidæ* and the *Sparidæ* is the circumstance that, though in the former the preorbital bones themselves do not cover the maxillary bones, it is true, still this is done by a dermal flap from the suborbital ring, when the mouth is closed. The Swedish name for the family, *Hafgösfiskar* (Sea Pike-perches), which has been introduced by NILSSON, is a suitable expression for the likeness of these fishes to the Perches, a likeness which does not vanish in their way of life. They are shore-fishes, though many of them, being excellent swimmers, are widely spread throughout the temperate and tropic parts of the ocean, and, like the genus *Roccus*, they sometimes make their way to fresh water at the mouths of large rivers or higher up the stream. The genus *Haploidonotus*, which we have just mentioned, and several species of other genera have their constant abode in lakes. In the Mediterranean the *Sciænidæ* have been known and valued from time immemorial; in the Red Sea, according to GÜNTHER, they are wanting. According to the same author the family includes about 130 species, distributed among 12 genera; JORDAN and GILBERT[e], however, assume no less than 25 genera. In the Scandinavian fauna only one of these genera can be adduced, and that only as an occasional visitor.

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[a] *Brit. Mus. Cat. Fish.*, II, p. 287.

[b] Cf. CUV., VAL., *Hist. Nat. d. Poiss.*, pl. 140.

[c] Cf. CUV., VAL., l. c., pl. 138 and 139, and GÜNTHER, *Study of Fishes*, pp. 142 etc., or *Handb. d. Ichth.*, pp. 95 etc.

[d] Cf. W. SORENSEN: *Om Lydorganer hos Fiske.* Kblivn 1884. pp. 162 etc. and the passages there referred to.

[e] *Syn. Fish. N. Amer.*, Bull. U. S. Nat. Mus., No. 16, p. 566.

Genus **SCIÆNA.**

No barbels on the chin, which does not project beyond the snout; no distinctly developed canine teeth on the jaws; no scales on the dorsal fins. The lower pharyngeals not united. Preoperculum dentated. Pseudobranchiæ distinct.

Distinguished by Artedi[a] under a limitation so wide as to correspond very nearly to the Sciænoid family of our times, this genus now includes only those species which agree with the characters, chiefly negative ones, which are given above and are the expression of the most typical generic form in the family. About 50 known species range themselves under these characters. The genus is spread over the Old World and the New, the Atlantic Ocean and the Pacific. Its classical name (*Σκίαινα* in Aristotle, *umbra* in Ovid, Columella and, at a later time, 1554, in Salvianus; *ombrina* among the Romans of the present day) means '*shadow-fish*'[b], but is difficult to explain, as the accounts of this genus given by the ancients are very meagre. In India, where these fishes are an important article of food and where, according to Day[c], their air-bladder is made into isinglass and exported to China, they are called *Bola* in Bengali.

THE MAIGRE (SW. HAFGÖSEN).

SCIÆNA AQUILA.

Fig. 13.

Second ray of the anal fin from $^2/_3$ to $^1/_3$ of the first soft ray in length and of about the same thickness as the latter. Number of branched rays in the second dorsal fin from 26 to 28. Diameter of the eye from $^1/_6$ to $^1/_7$[d] of the length of the head. Colour of the body silver-white, darker on the back. An indistinct, blackish gray spot on the operculum.

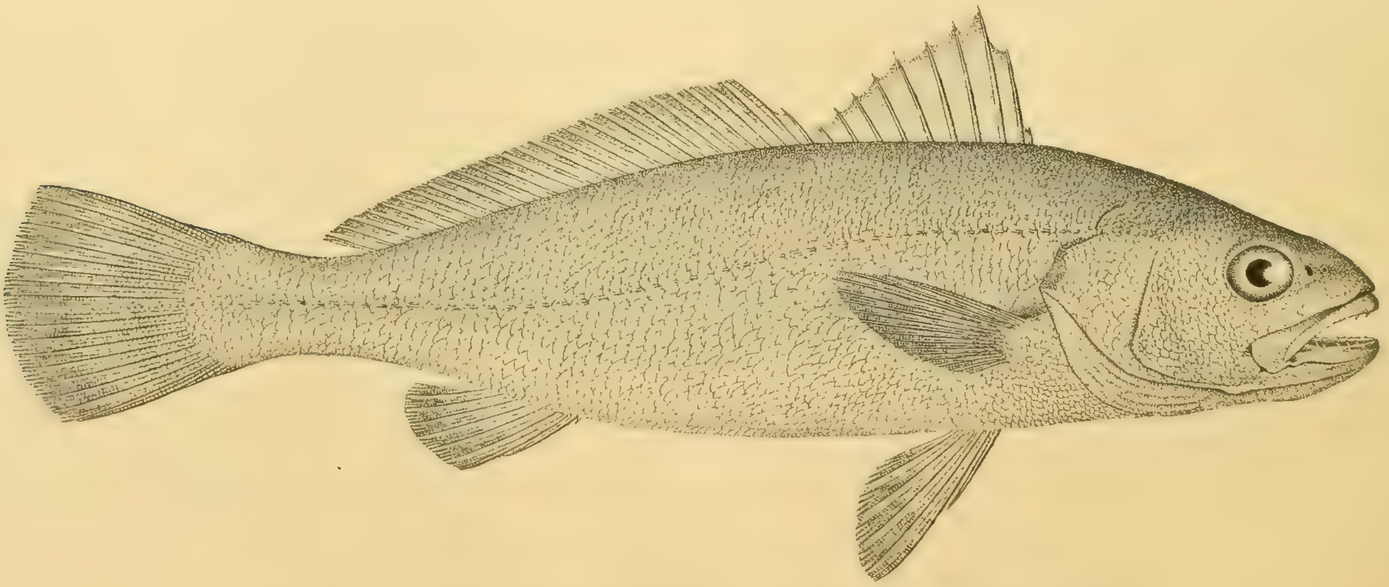

Fig. 13. Maigre (*Sciæna aquila*) from the Mediterranean. $^2/_3$ of the natural size.

R. br. 7; *D.* 10 $\frac{1}{26\text{—}28}$[e]; *A.* $\frac{2}{7}$[f]; *P.* 2 + 15[g]; *V.* $^1/_5$; *C.* *x* + 15 + *x*; *L. lat.* 50—55[h].

Syn: *Maigre*, Duhamel, *Pêch.*, part. 2 (vol. III), sect. 6, p. 137, tab. 1 fig. 3.

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[a] *Gen. Pisc.*, p. 38.

[b] Cf. Cuv., Val., *Hist. Nat. d. Poiss.*, V, pp. 12 etc.

[c] *Fish. Gt. Brit.*, *Irel.*, pt. I, p. 149.

[d] In young specimens $^3/_{17}$, according to Steindachner, *Ichth. Reis. Sp. Port.*, Stzgber. Akad. Wien, Mat. Naturv. Cl. 1867, Bd. 56, I, p. 640.

[e] 29, according to Day, l. c.

[f] Sometimes, but seldom $\frac{2}{8}$, according to Moreau, *Hist. Nat. Poiss. Fr.*, II, p. 401.

[g] *P.* 19, according to Lilljeborg, l. c.

[h] Excluding the scales of the caudal fin.

Cheilodipterus aquila, Lacép., *Hist. Nat. Poiss.*, V, p. 684; Cuv., Val., (*Sciæna*), *Hist. Nat. Poiss.*, V, p. 28, tab. 100; Nilss., *Skand. Fn.*, *Fisk.*, p. 756; Lillj., *Sv.*, *Norg. Fisk.*, I, p. 199; Hansen, *Zool. Dan.*, *Fiske*, p. 32, tab. V, fig. 5.

Sciæna umbra, Cuv., *R. Anim.*, ed. II, vol. II, p. 172; Bonap., *Fn. Ital.*, vol. III, tab. 88, fig. 1, p. 65.

Sciæna antarctica, Castelnau, Proc. Zool. Soc. Vict. 1872, p. 100; Ten.-Woods, *N. S. Wal. Fish. and Fisher.*, p. 53, tab. XVI.

What first attracts our attention in the appearance of the Maigre, when we compare it with the preceding Percomorphi, is the great length of the second dorsal fin and the shortness of the anal. The plentiful covering of scales on the head reminds us most of the Sea-perch, and the grayish black spot which we see on the operculum through the silver (sometimes golden) sheen of the scales, increases this resemblance and thus explains the confusion of these two species which we often find among fishermen.[a] Both reach a very considerable size, though in this respect the Maigre far surpasses the Sea-perch, as it attains a length of at least 2 metres. The form of the body is about the same as that of the Sea-perch. In the Maigre, as well as in the Sea-perch the length of the body is 4 or 5 times the greatest depth, and from 4 to $4^1/_2$ times the length of the head. But the least depth of the body (the least depth of the tail) is smaller[b] in the Maigre, being about 36 % of the greatest depth, whereas in the Sea-perch it is about 45 %[c]. Besides these, the most remarkable point in the external appearance of the Maigre is the oblique position of the scales, directed, as they are, posteriorly upwards. According to Steindachner (l. c.), the caudal fin is completely covered with scales, which, however, easily drop off. On each side of the bases of the dorsal fins the skin grows into a longitudinal, scaly flap, thus forming a groove in which these fins may be partly concealed. The dental equipment of the mouth, too, is quite unlike that of the Sea-perch, for though the Maigre has not so large canine teeth as the Sciænoid genera *Otolithus* and *Ancylodon*, still it has an outer row of large, scattered jaw-teeth, largest on the intermaxillaries, which project from the velvety, papillose skin, which in its turn conceals the inner patch of cardiform teeth. The gill-rakers are strong, and on the front of the first branchial arch and almost universally on the anterior side of the back ones they change into large, spinous nodules, while on the pharyngeals, upper and lower, they are developed into cardiform rows of strong and pointed teeth. The first spinous ray in the anal fin is extremely short and often hidden by skin and scales, while the second is weak in comparison with the rays in that group of the genus to which Cuvier has given the generic name *Corvina*.

The bright and gorgeous silver-gray colour of the body becomes white on the belly and shades off into brown on the back, while on the occiput, according to Day, it is green with a lustre of purple and gold. However, these shades vary very considerably. The fins are reddish brown or red, the dorsal and caudal, according to Steindachner, edged with gray, as are also the ends of the pectoral and anal fins, according to Day. The scales on the body are punctated with fine, black dots.

According to Yarrell[d], the Maigre is seldom taken less than 3 feet in length off the English coast. It is not common there, though, according to Day, it is sometimes taken in numbers off the coast of Devonshire and Cornwall. Steindachner procured small specimens in Cadiz and Barcelona. Geoffroy St. Hilaire and Ehrenberg also brought home small specimens from Egypt, a circumstance which led Cuvier to conjecture that the Maigre spawns along the south coast of the Mediterranean, as one can never get small Maigres on the north coast.

The Maigre is distinctly a fish of prey, and seems to follow the sardine-shoals in the Mediterranean and the neighbouring part of the Atlantic. Still it is seldom taken on a hook[e], but usually in a large-meshed net, and Duhamel declares that the fishermen can detect where the fish is and where to set the net, by its "song", which is said to be audible from a depth of twenty fathoms. It is valued not only as food — the head is especially prized — but also for the large 'otolithes' (hearing-stones) which distinguish all the *Sciænidæ*. To these is ascribed a magic power: they are kept as talismans and used as a cure for colic, if they have been received as a gift, but if purchased, they are thought useless.

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[a] Cf. Duhamel, l. c. p. 136 and Cuvier, l. c.

[b] 7.2 % of the length of the body in a specimen 268 mm. long.

[c] 9.8 % „ „ „ „ „ „ „ „ „ 275 „ „

[d] *Brit. Fish.*, ed. 2, vol. I, p. 107.

[e] According to Tenison-Woods (l. c.), in Australia the large Maigres are caught with hook and line, the small ones in drag-nets.

One specimen of this species has wandered into the Sound. "It was found," says Nilsson, "on the 24th of December, 1852, not far from shore, outside Ålstorp south of Landskrona. The fish was stranded among the seaweed, where it lay and lashed about in its struggles to get free. It was killed with boathooks by the fishermen and brought to Lund after the holidays, where it has since been stuffed and is preserved in the University Zoological Museum. It was 5 feet long and weighed $67^1/_2$ lbs."

The Royal Museum has a specimen of the Maigre from Cape Colony, where this species is said to be very common, and from which place came the specimens first described by Lacépède and Cuvier[a] under the name *Labrus* (*Sciæna*) *hololepidotus*. Another specimen, which has formed the basis of the above remarks and the figure, has been obtained by the Museum from the Museum of Vienna through the generosity of Professor Steindachner.

Fam. **SPARIDÆ.**

Form of the body deep and compressed. External bones of the head smooth: the first two suborbital (preorbital) bones, often united, broad and covering the maxillary bones when the mouth is closed. Scales ctenoid or cycloid. The scales of the body are, as a rule, not continued over the dorsal or anal fin, but these fins may generally be partly concealed in a groove formed by a scaly fold of skin. One continuous dorsal fin, the spinous-rayed part of which is about equal in extent to the soft-rayed, or a little longer. System of the lateral line but little developed on the head. Either closely-set, cutting or pointed, at least somewhat compressed teeth in the front of the jaws, or obtuse teeth on the posterior parts of the intermaxillaries and the mandible. Palate and tongue without teeth. Chin without barbels. Ventral fins thoracic, with one spinous ray and five soft.

This family, like the preceding one, was preconceived by Artedi. The definition he gave his genus *Sparus*[b], in Cuvier's system was represented by the two families *Sparidæ* and *Mænidæ*[c], and the character to which Artedi seems to have paid most attention, namely the nature of the jaw-teeth, is still of service in the system of our own times for the generic division of the family *Sparidæ*.

The *Sparidæ*, to which Nilsson has given the Swedish name *hafsrudefiskar* (Sea Gibel Carps) on account of the general depth of the body, occupy a peculiar intermediate position, which makes a definition of the family very difficult. The deep form of the body, and the movable cardiform teeth of certain species remind us of the scale-finned fishes (*Squamipinnes*), while other species, with their flat, sharp front-teeth, point to the *Teuthididæ*. Again, the long, pointed, sometimes falcate pectoral fins call to mind the Mackerel group, while the deep snout and the strong, conical front-teeth in other species remind us of their close resemblance to *Hæmulon* and some other genera of the Percoid family. Although they are without the marked development of the muciferous system of the lateral line which we find in the Sciænidæ and which consists in its extension over the head, still the naked (scaleless) parts of the head are generally covered with a skin densely pierced by fine pores. It is at the margins of the preorbital bones and the preoperculum that these pores most clearly develop into attenuated, horizontal tubes. Similar tubes, spread out like the fingers of a hand, occur too on the posttemporal bones, which in their posterior part appear like scales, on the scales in an oblique row[d] ascending from these bones, on a corresponding row of scales in the same direction from the superior articulation of the preoperculum and on the scales which cover the posterior suborbital bones. The direction of these rows of scales may vary, so that those which ascend from the posttemporal bone and the preoperculum may meet, or the latter take an opposite course, more obliquely forwards, over the forehead; but still their appearance clearly shows that they correspond to the so-called muciferous ducts on the head, and they may be found, though they are not so distinct, even in the common Perch.

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[a] Lacép., (*Labrus*) l. c., III, p. 517, pl. 21, fig. 2; Cuv.. Val., (*Sciæna*) l. c., p. 53; Smith: *Ill. Zool. S. Afr.*, *Fish.*, pl. XV.

[b] *Gen. Pisc.*, p. 35.

[c] *Regn. Anim.*, ed. 2. vol. II, p. 180 (*Sparoides*) and p. 186 (*Mænides*).

[d] Valenciennes and Bonaparte called this row of scales *squamæ superscapulares*, Winther in *Zoologia Danica Fiske*. Forklaring til Tavlerne, p. II, fig. 2, *k*, has called it "Sideliniens Nakkegren" (the occipital branch of the lateral line).

In their manner of life the *Sparidæ* closely resemble the *Labridæ*, and several exotic genera of the former family are also very like the Wrasses in appearance. The principal character of the *Sparidæ*, too, is expressed in their strong teeth, adapted for crushing or biting their food, and many of them are remarkable for their thick lips, sometimes fringed with a velvety, papillose covering, which may be continued into the mouth and there change into a coat of longitudinal folds on the palate and tongue[a]. They live for the most part on mussels and other shellfish or crustaceans, the shells of which they have to crush. Some species, however, which are provided with a longer digestive canal than the others, feed principally on seaweed. In consequence of this diet the Sparidæ are generally shore-fishes, which, while young, live in shallow and tidal waters, but in old age keep to deep water. The young are often found in shoals, the old ones, on the contrary, are generally of solitary habits. From olden times they have been highly esteemed among Mediterranean fishes by the Greeks and Romans, and one species, the Gilt-head (*Sparus aurata*) was kept alive in captivity and fed on mussels, to form a highly prized dish. But the family is no less valuable in domestic economy in America, where the Sheep's-head (*Diplodus probatocephalus* *Sargus ovis*), which attains a length of 35 inches and a weight of 14 or 15 lbs., is considered one of the most delicious salt-water fishes of the United States[b], or in Australia, where the Schnapper (*Sparus unicolor*), which may weigh as much as 28 lbs.[c], is held in as great esteem.

The family includes about 120 known species from the tropic and temperate seas and the brackish waters round their coasts. Of the four groups into which it is divided (subfamilies: *Cantharini*, *Bogini*[d], *Sargini*, *Sparini*), and which have been distinguished by CUVIER[e], VALENCIENNES[f] and GÜNTHER[g] on account of the difference in the form of their teeth, there are two which, though only on occasions more or less frequent, are represented in the Scandinavian Fauna, the first, *Cantharini*, including the forms which have only pointed, cardiform teeth, the second, *Sparini*, containing those which in the front of the mouth have pointed, cardiform teeth or canines and on the back of the jaws obtuse, molar teeth. Of each subfamily we have only to give one genus.

GENUS CANTHARUS.

The jaw-teeth form anteriorly a dense, strong card, the outer row of which consists of larger teeth than the others.

The European side of the Atlantic, the Mediterranean and the African side of the Indian Ocean, form the habitat of the genus *Cantharus*, whereof GÜNTHER in his *Catalogue* (l. c.) has only cited 6 species as certainly belonging to it. Three of these, he says, belong to the Mediterranean and the Atlantic outside it, three to the Cape and the Seychelles. STEINDACHNER[h], however, has combined two of the first-mentioned species into one, and if this was done with good reason, as certainly seems to be the case, we are compelled also to assume that the third Mediterranean species has no greater right to its position, since the characters given by VALENCIENNES for *Cantharus orbicularis*[i], have most of the appearance of characters of age.

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[a] This structure is especially beautiful in *Sparus erythrinus*, for example.

[b] Cf. CUV., VAL., *Hist. Nat. Poiss.*, VI, p. 55, following MITCHILL.

[c] Cf. TENISON-WOODS, *Fish a. Fisher. N. S. Wales*, p. 40.

[d] *Obladini*, MOREAU, *Hist. Nat. Poiss. Fr.*, III, p. 13.

[e] *Règn. Anim.*, ed. 2, vol. II, pp. 181, etc.

[f] CUV., VAL., *Hist. Nat. Poiss.*, VI, pp. 6, etc.

Cat. Brit. Mus., Fish., I, p. 412.

[h] Stzber. Akad. Wiss. Wien, LVI, I (1867), p. 649.

[i] CUV., VAL., *Hist. Nat. Poiss.*, VI, p. 331.

THE BLACK SEA-BREAM (SW. HAFSRUDAN).

CANTHARUS LINEATUS.

Fig. 14.

Colouring of the body gray with a blue or greenish lustre, during youth marked with transverse bands. Along the middle of the rows of scales run yellowish brown longitudinal streaks, darkest on the lateral line. Both the superior-posterior lines of muciferous ducts on the head meet on the occiput, are dark and include on each side a triangular patch of common scales, which points upwards.

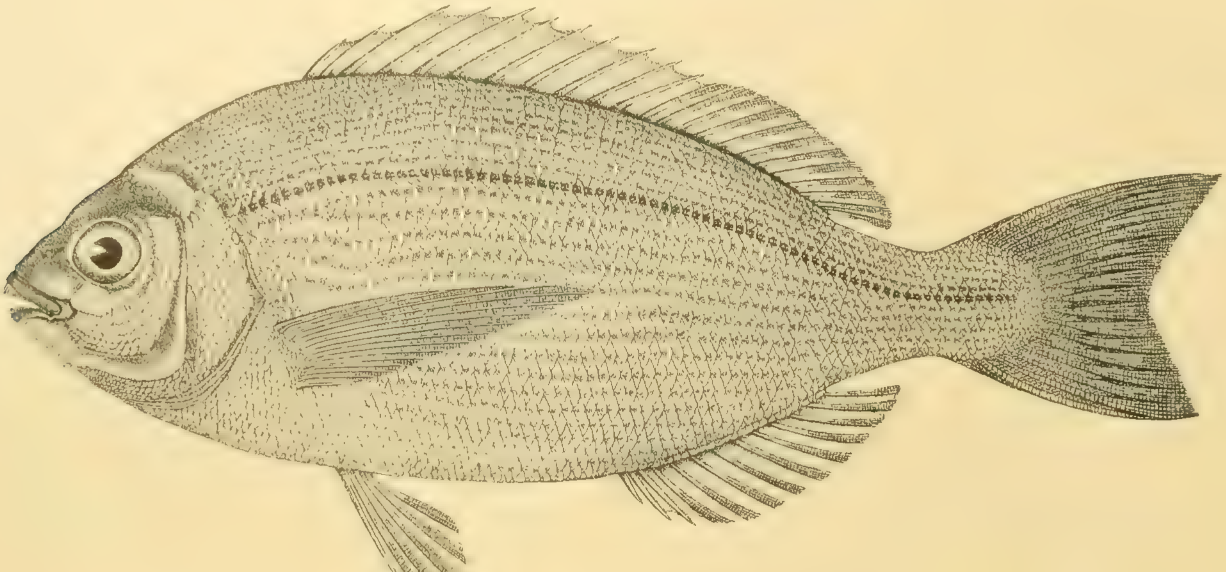

Fig. 14. *Black Sea-Bream (Cantharus lineatus)* from Christiania Fjord. $^1/_2$ natural size.

R. br. 6; *D.* $\frac{11}{12}$; *A.* $\frac{3}{10}$; *P.* 2 + 13 + 1; *V.* $\frac{1}{5}$; *C.* $x + 15 + x$;

L. lat. 72—74[a]; *L. tr.* $\frac{8}{18}+1$[b].

Syn. **Κάνϑαρος**, Aristotle, *Cantharus*, Ovid, *Scarabæus*, Gaza (vide Artedi).

Sparus lineis utrinque luteis longitudinaliter parallelis, iride argentea. Art., *Gen. Pisc.*, p. 36; *Syn.* p. 58.

Sparus Cantharus, Lin., *Syst. Nat.*, ed. X, tom. I, p. 280.

Sparus lineatus, Montagu, Mem. Wern. Nat. Hist. Soc., II, (1815) p. 451, tab. XXIII; Gthr (*Cantharus*), *Cat. Brit. Mus.*, *Fish.*, I, p. 413; Lütk., Vid. Meddel. Naturh. For. Kbhvn 1865, p. 220; Coll., Vid. Selsk. Forh. Christiania 1874, Tillægsh., p. 17; Winth., Naturh. Tidskr. Kbhvn, ser. III, Bd XII (1879), p. 8; Id., *Zool. Dan.*, *Fiske*, p. 14, tab. III, fig. 1; Day, *Fish. G:t Brit.*, *Irel.*, I, p. 26, tab. IX; Lilljeb., *Sv.*, *Norg. Fn.*, *Fisk.*, I, p. 210; Coll., N. Mag. Naturv. Christ., Bd. 29 (1884), p. 50.

Cantharus vulgaris, *Canth. brama*, *Canth. orbicularis*(?), *Canth. griseus*, Val. in Cuv., Val., *Hist. Nat. Poiss.*, VI, pp. 319, 328, 331, 333, tab. 160; *Canth. griseus* et *Canth. vulgaris*, Nilss., *Skand. Fn.*, *Fisk.*, pp. 118 et 119; (?)*Canth. orbicularis*, Bonap., *Fn. Ital.*, vol. III (*Pesci*), tab. 89; *Canth. griseus*, *Canth. brama*, (?)*Canth. orbicularis*, Moreau, *Hist. Nat. Poiss. Fr.*, vol. III, pp. 49, 52, 54.

Cantharus Linnei, Malm, *Gbgs*, *Boh. Fn.*, pp. 97 et 384.

Obs. With regard to the relation between *Cantharus lineatus* and *C. brama* Steindachner (l. c.) has reminded us of the doubtfulness of a character derived from the presence or absence of an incision in the lower margin of the preorbital bone (between the two anterior suborbital bones) to receive the knob on the maxillary bone, which is quite as inconstant. Though Bonaparte (l. c.) employs this character in his diagnosis of *C. orbicularis*, both in his figure and his description of the species there occurs a slight curve (*un leggero sino*) in this margin. As far as the form of the body is concerned, in which respect *C. orbicularis* could at most be regarded only as a variety with a deeper form, it is also remarkable that the depth of the body, which according to Steindachner increases with age, may rise as high as $^7/_{20}$ of the length[c] in *C. lineatus*, while in *C. orbicularis* it may be as low as $^4/_{11}$[d], a circumstance which reduces the expression for this character to $1^1/_3$ % of the length of the body.

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[a] 68—72 (+5 or 6 on the caudal fin), according to Steindachner (l. c.).

[b] $\frac{9^1/_2—10^1/_2}{18—19}+1$, according to Steindachner (l. c.).

[c] Steindachner (l. c.).

[d] Moreau, l. c., p. 54.

The form of body of the Black Sea-Bream is one of the most typical and regular in the family. The curves of the back, which is sharply compressed, and of the belly, which is flatly rounded as far back as the anal fin, are almost equal. The eye is of average size, and the snout proportional, neither excessively high, nor too low. In the specimen we have examined, kindly lent by the University Museum of Christiania, the length of the body, from the snout to the end of the middle rays of the caudal fin, is 30 cm., the greatest depth 36 % of the length, and the greatest thickness, measured on about a level with the insertion of the pectoral fins and half-way along them, is 38 % of the greatest depth. The least depth of the body (that of the tail) is 26 % of the greatest depth or 9.3 % of the length, of which the length of the head forms 24.8 %. The vertical and horizontal diameters of the eye are equal and measure 22.4 % of the length of the head or $^2/_3$ of the breadth of the convex interorbital space at the middle of the eyes. The breadth of this space, as well as the length of the lower jaw, is about equal to $^1/_3$ of the length of the head.

When the dorsal or the anal fin is depressed, the spinous-rayed part is completely hidden in the fin-groove. According to STEINDACHNER (l. c.) the caudal fin is covered with scales right out to the hind margin. On the dorsal and anal fins I can find no trace of scales. On the cheek there are 5 rows of scales, and in addition to these, at the lower posterior angle, two scales, so that counting from these there are 6 rows. On the operculum 9 rows of scales. In a transverse line straight up from the insertion of the ventral fins there are 18 scales below the lateral line and 8 above it, more anteriorly the latter are more numerous. The scales are covered with fine, pointed granules in radiating lines, the outermost granules becoming pointed teeth or fine bristles at the margin of the scale. The posterior dorsal branch in the system of the lateral line on the head (the posttemporal branch) is naked (without scales) anteriorly, and bounded posteriorly by 12 scales (*squamæ superscapulares*, VAL. et BONAP.), above which the lateral outlets of the canal spread out like the fingers of a hand. The anterior dorsal branch is situated at the limit of the scales on the head (occiput). In the scales of the lateral line the duct is branched 3 or sometimes 5 times, so that above and below the large (middle)pore there appear one or two lateral pores[a].

For information on other points we may refer to the figure.

The colouring of the Black Sea-Bream is very variable, and is thus described by DAY[b]: "gray, becoming lighter and dashed with gold on the sides and beneath: forehead and cheeks purplish. Below the lateral line are 3 or 4 parallel, or sometimes irregularly horizontal golden bands, along the body. Dorsal fin dark, with 2 or 3 nearly black bands composed of spots. Pectoral, caudal and anal straw-coloured. Caudal gray-edged, margined externally with white: some bands of spots along the anal. Ventral slate-colour along the centre, with light or even white edges."

From its proper home, the Mediterranean and the Atlantic between the Canary Islands and England, the Black Sea-Bream has several times wandered north and been met with on the south coast of Norway, up to Trondhjem Fjord[c]. On only one single occasion, however, has it been found in Swedish waters: this was in 1840, when a specimen $18^1/_2$ in. long was taken off the Scanian coast[d]. It is extremely improbable that it propagates its species north of England, as only full-grown specimens, and never small fry, have been taken there. According to COUCH[e] it prefers a rocky bottom and sometimes enters harbours and inlets, where it is generally caught with rod and line, mussels being the best bait. He says, however, that "it also feeds on the finer kind of seaweeds, upon which it becomes exceedingly fat." Its flesh is generally little esteemed, but in the north of France it is considered fairly good[f].

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[a] This is also the case in *Cantharus orbicularis*, according to BONAPARTE's figure and description.

[b] *Fish. G:t Brit., Irel.*, l. c.

[c] Cf. COLLETT, l. c.

[d] NILSSON, *Skand. Fn.*, l. c., p. 120.

[e] *Fish. Brit. Isl.*, I, p. 222.

[f] VALENCIENNES, l. c., p. 337.

GENUS SPARUS.

The front-teeth of the jaws form a card of pointed or somewhat obtuse, curved or straight (conical) teeth, largest in the outer row; back-teeth obtuse, rounded molars in two or more rows. Cheeks scaly.

By this definition, as in BLEEKER[a] and most recently in JORDAN and GILBERT[b], the genus *Sparus* of ARTEDI is more nearly restored to its original signification, as it is made to include CUVIER's and VALENCIENNES' genera *Chrysophrys*, *Pagrus* and *Pagellus*. STEINDACHNER[c] proved that the generic distinction between *Chrysophrys* and *Pagrus* was untenable, but he did not restore the generic name of ARTEDI and LINNÆUS, and herein he is followed by DAY[d]. But BLEEKER followed up this train of thought, which may, however, be held to have originated with VALENCIENNES, who cited[e] the intermediate forms which unite these three genera.

Obs. One of the clearest proofs of the correctness of this combination of *Pagellus* and *Pagrus* as well, seems to me to result from a closer examination of the characters of *Sparus mormyrus*, the species that LINNÆUS has described under the name of *Sp. hurta*[f], as is shown by the type-specimen from *Museum Adolphi Friderici*, which still exists in the Royal Museum. This specimen — with *R. br.* 6; $D.\ \frac{11[g]}{12}$; $A.\ \frac{3}{10}$; *P.* 2+14; $V.\ \frac{1}{5}$: *C.* $x + 15 + x$; *L. lat.* 60 l. 62: *L. tr.* $\frac{6}{12} + 1$[h] — has cardiform, but firm and obtuse front-teeth, in the anterior part of the jaws somewhat pointed in the outer row only, where they are larger and comparatively far apart, almost like the lateral teeth in *Sparus pagrus*, but in the posterior part of the jaws obtuse. In the lower jaw, too, all the teeth are molar-like, except the two first, which are pointed and project slightly forward (exserti: LIN.). In the upper jaw the four or five front-teeth in the outer row are more pointed than the others and separated from them by an interval (superiores 4, quasi canini[i]: LIN.). DAY's assertion (l. c., p. 35) as to the relation between *Pagrus* and *Pagellus*, that the latter has much smaller molars than the former, entirely falls to the ground in the case of this specimen, as the posterior inner molar teeth in the upper jaw are comparatively large and remarkably broad. That this specimen, the *hurta* of LINNÆUS, is not of the same species as RISSO's *Aurata hurta*[j], need scarcely be remarked, in spite of the fact that such a conclusion apparently finds some support in LINNÆUS's incorrect statement of the number of rays in the anal fin[k]. Still we must notice that the name *hurta*, which otherwise seems to be unknown, may well have arisen through a slip of LINNÆUS's pen (instead of *aurata*), for together with the above-mentioned specimen of *Sparus mormyrus* there was in the jar signed by himself, a specimen of *Sp. aurata* 210 mm. in length. Perhaps LINNÆUS found both of them in *Museum Adolphi Friderici* sent in with the name *Aurata* illegibly written; and his description, too, seems to point to a confusion of notes on the characters of both specimens, though the description of the colouring (transverse bands on the body) clearly refers to *Sp. mormyrus*.

The genus *Sparus* of ARTEDI, which from CUVIER's time up to BLEEKER's had been erased from the system, may thus be restored with complete justice, the more so, as the case in this family is remarkably like that which we have seen in the *Labridæ*, where it has also been proposed, on account of the jaw-teeth being set in one or several rows to split up the old genus *Labrus*.

The genus *Sparus*, to which we may refer 37 species, adopted and described by GÜNTHER in his Catalogue, is spread over the whole geographical range of the family. Off the coast of Scandinavia only two species have been met with, both belonging to the group which has borne the name *Pagellus*, i. e., with cardiform teeth and no canines in the front of the jaws. In both species the pectoral fins are longer than the distance from the insertion of the ventrals to the beginning of the anal, and the horizontal diameter of the eye greater than the breadth of the snout across the 'articulation-knobs' of the maxillaries; but in the one (*Sparus erythrinus*) this breadth is more than $^1/_3$ of the base of the anal fin, while in the other (*Sparus centrodontus*) it is less.

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[a] *Atl. Ichth.*, Tome VIII, p. 106.

[b] *Syn. Fish. N. Amer.*, Bull. U. S. Nat. Mus., N:o 16, p. 555.

[c] Stzber. Akad. Wiss. Wien, LVI, I (1867), p. 657.

[d] *Fish. G:t Brit.*, *Irel.*, I, p. 30.

[e] CUV., VAL., *Hist. Nat. Poiss.*, vol. VI, p. 141.

[f] *Syst. Nat.*, ed. X, tom. I, p. 279; *Mus. Ad. Fr.*, tom. II prodr., p. 73.

[g] The third and fourth spinous rays in the dorsal fin are the longest and are equal in length (tertio longo, LIN.). Their length = $^1/_3$ of the greatest depth of the body and is about equal to the height of the anterior preorbital bone.

[h] Vertically from the insertion of the ventral fins.

[i] Perhaps, however, LINNÆUS's description of the teeth is taken, at least in part, from a specimen of *Sparus aurata* (see below).

[j] *Hist. Nat. Eur. Mér.*, Tome III, p. 358.

[k] $^3/_9$, i. e. 6 soft rays instead of 10.

Obs. In order to comprehend the mutual relations of the species within this group of the genus *Sparus*, it must be of interest to see how far certain relations point to a fixed direction of development in the difference of species. In several respects, it is true, this difference is connected with the difference in the depth of the water where they live, and this consists, as usual, in the greater or smaller size of the eyes. To a great extent, too, it may depend, as we see in some of the corresponding circumstances in the *Salmonidæ*[a], on the preponderating influence of sex on the development, on which point, however, we cannot give any opinion here owing to the lack of the necessary information. In other cases, on the contrary, the difference in form runs parallel to the individual development, and enables us to trace the natural, generic course of development. The appended comparative table gives examples of the relations mentioned, and simultaneously states the most apparent and constant characters of three species represented by one specimen of *Sparus mormyrus* (Linnæus's type-specimen of *Sp. hurta*), one specimen of *Sp. erythrinus* from Nice, kindly lent to me by the Museum of Upsala University, and two specimens of *Sp. centrodontus*, the younger from Bohuslän and the older from the Atlantic outside Bergen.

	Sparus mormyrus	*Sparus erythrinus*	*Sparus centrodontus*	
Length of the body, expressed in mm.	248	224	292	333
Breadth of the snout[b] in % of the length of the lower jaw	53.6	51.9	50	48.7
,, ,, ,, ,, ,, ,, ,, ,, interorbital space[c]	71.4	66.6	61.5	56.2
Interorbital space ,, ,, ,, ,, length of the head	28.4	31	31.7	33
Length of the snout[d] ,, ,, ,, ,, ,, ,, ,, ,,	51.3	43.4	30.5	30
Base of the anal fin in % of the distance between the tip of the snout and the beginning of the dorsal fin	41.1	48.3	53.3	54.7
Horizontal diameter of the eye in % of the length of the body	5.7	7.4	8.2	8
,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, head	19	24.3	29.2	27.3
,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, snout	37	56	96	91.4
,, ,, ,, ,, ,, ,, ,, ,, ,, breadth ,, ,, interorbital space	66.6	78.6	92.3	82.8
,, ,, ,, ,, ,, ,, ,, ,, ,, length ,, ,, lower jaw	50	61.1	75	71.6
,, ,, ,, ,, ,, ,, ,, ,, ,, least depth of the tail	60.9	94.3	100	96.4
Length of the snout in % of the length of the body	15.3	13.1	8.6	8.7
Base of the anal fin ,, ,, ,, ,, ,, ,, ,, head	55.4	57.3	68.3	66
Postabdominal length[e] ,, ,, ,, ,, distance of the dorsal fin from the tip of the snout	64.6	69.5	78.1	77.8
Breadth of the snout in % of the base of the anal fin	36.6	36	28.6	28.1
Postabdominal length in % of the length of the body	25.8	25.4	28.1	27.3
Base of the anal fin ,, ,, ,, ,, ,, ,, ,, ,,	16.5	17.4	19.1	19.2
Least depth of the tail ,, ,, ,, ,, ,, ,, ,, ,,	9.2	7.8	8.2	8.2
Length of the pectoral fins ,, ,, ,, ,, ,, ,, ,, ,,	23.0	33	29.4	30
,, ,, ,, ventral fins in % of the length of the pectoral fins	70.0	51.7	57	54

The differences arising from the direction of development common to the whole genus, expressed in their proportions, run uniformly through all these four columns, rising or falling. The other differences are those with regard to which we have to look for the grounds for the interruption of the serial arrangement in local or sexual circumstances. The comparison shows that *Sparus mormyrus*, which lives in the shallower parts of the Mediterranean, seems in its characters to come nearest the original type of the genus, which might have been especially distinguished by smaller eyes, shorter pectoral fins and a higher cheek, as well as a higher peduncle of the caudal fin. This species is also distinguished by the transverse bands, which call to mind the juvenile colouring of other species.

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[a] Smitt: *Kritisk Förteckning öfver de i Riksmuseum befintliga Salmonider*, K. Vet.-Akad:s Handl., Bd. 21, N:r 8.

[b] The breadth of the snout here, as everywhere in this work where nothing else is remarked, is measured across the outer edges of the knobs of articulation of the maxillaries.

[c] The breadth of the interorbital space here represents the breadth of the forehead from one orbital margin to the other, *across the middle of the eyes*, and is thus far from always the least breadth of the forehead.

[d] The length of the snout is measured from the anterior margin of the orbit to the middle of the tip of the snout. Steindachner (l. c.) has evidently taken this measurement in another way.

[e] As in the treatise on the Salmonidæ of the Royal Museum mentioned above, I give this name to the distance between the foremost point of the insertion of the ventral fins and the beginning of the anal.

THE SPANISH SEA-BREAM.

SPARUS ERYTHRINUS.

Fig. 15.

Length of the snout more than $^1/_3$ of the length of the head, its breadth more than $^1/_3$ of the base of the anal fin, the length of which is, however, less than half the distance from the tip of the snout to the beginning of the dorsal fin, and also than $1^1/_2$ times the length of the lower jaw. Longitudinal diameter of the eye more than $^3/_4$ of the least depth of the tail, which is about $^1/_4$, or at any rate less than $^3/_{10}$ of the length of the head or the greatest depth of the body. Occipital branches of the lateral line but slightly marked. Colouring of the body scarlet with golden and silver lustre, sometimes spotted with blue, in youth with rose-red transverse bands, whitish on the ventral sides.

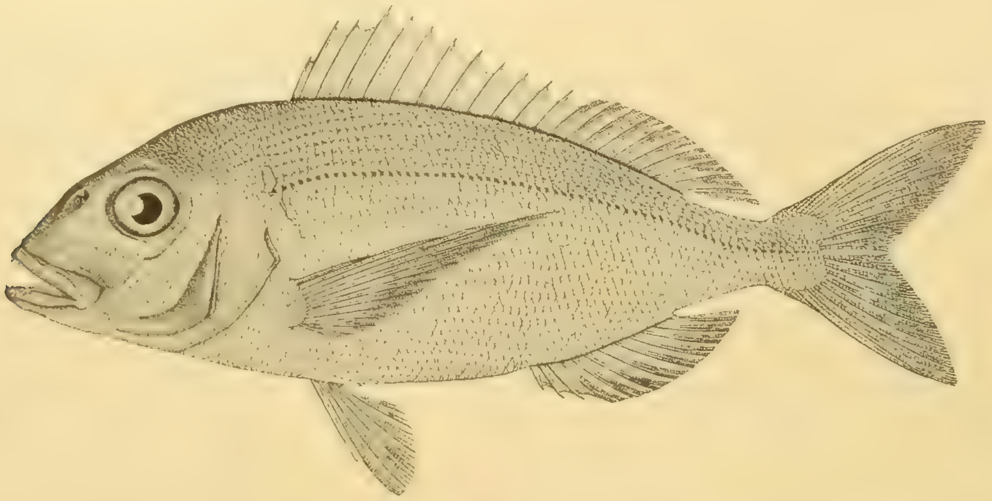

Fig. 15. *Spanish Sea-Bream* (*Sparus erythrinus*) from the Mediterranean. $^1/_2$ natural size.

R. br. 6; *D.* $\frac{12}{10}$; *A.* $\frac{3}{9}$; *P.* 2 + 11 + 2 l. 2 + 12 + 1; *V.* $\frac{1}{5}$; *C.* $x + 15 + x$; *L. lat.* 60[a]; *L. tr.* $\frac{6}{14} + 1$[b].

Syn. *Ερυθρινός* et *Ερύθρινος* ARISTOTLE; *Rubellio*, SALVIANUS (sec. ARTEDI).

Sparus totus rubens, Iride argentea, ART., *Gen. Pisc.*, p. 36; *Syn.*, p. 59.

Sparus erythrinus, LIN., *Syst. Nat.*, ed. X, tom. I, p. 279; RISSO (*Pagrus*), *Hist. Nat. Eur. Mér.*, vol. III, p. 361; CUV., VAL. (*Pagellus*), *Hist. Nat. Poiss.*, vol. VI, p. 170, tab. 150; GTHR, *Brit. Mus. Cat.*, *Fish.*, vol. I, p. 473; STEIND., Sitzber. Akad. Wiss. Wien, LVI, I (1867), p. 660; WINTH., *Zool. Dan.*, *Fiske*, p. 15, tab. III, fig. 3; ID., Naturh. Tidskr. Kbhvn, ser. 3, vol. XII (1879), p, 9; LILLJ., *Sv.*, *Norg. Fn.*, *Fisk.*, vol. I, p. 220.

The Spanish Sea-Bream is one of the most common fishes in the Mediterranean and the Atlantic outside it, and as an article of food is by no means despised. Its ordinary size seems to be between 280 and 320 mm.: — according to STEINDACHNER specimens 440 mm. and more in length are extremely rare in its true home. Just such a specimen, however, 460 mm. long, has once been taken within the limits of the Scandinavian Fauna, on the 4th of March, 1873, off the Skaw[c]. According to DUHAMEL it generally lives at a depth of from 50 to 60 fathoms[d]. As far north as the south and west coasts of England, according to DAY[e], it is common, but off Scotland and Holland it is rare. The catch at the Skaw must thus be considered only as a wandering stranger.

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[a] 56—60 according to DAY, 60—61 according to STEINDACHNER.

[b] Vertically from the insertion of the ventral fins.

[c] Cf. WINTHER, l. c.

[d] *Traité des Pêches*, sect. IV, chap. II, p. 30.

[e] *Fish. G:t Brit., Irel.*, I, p. 41.

THE COMMON SEA-BREAM (SW. BLANKESTENEN OR FLÄCKPAGELLEN).

SPARUS CENTRODONTUS.

Fig. 16.

Length of the snout less than $^1/_3$ of the length of the head, its breadth less than $^1/_3$ of the base of the anal fin, the length of which is, however, more than (at least equal to) half the distance from the tip of the snout to the beginning of the dorsal fin, and also more than $1^1/_2$ times the length of the lower jaw. Longitudinal diameter of the eye more than $^3/_4$ of the least depth of the tail, which is less than $^3/_{10}$ of the length of the head or the greatest depth of the body. Occipital branches of the system of the lateral line distinct and including between them a crescent-shaped patch of common scales. Colour of the body red with a golden and silver lustre, back dark, belly whitish; in adult specimens a black spot on the shoulder at the beginning of the lateral line.

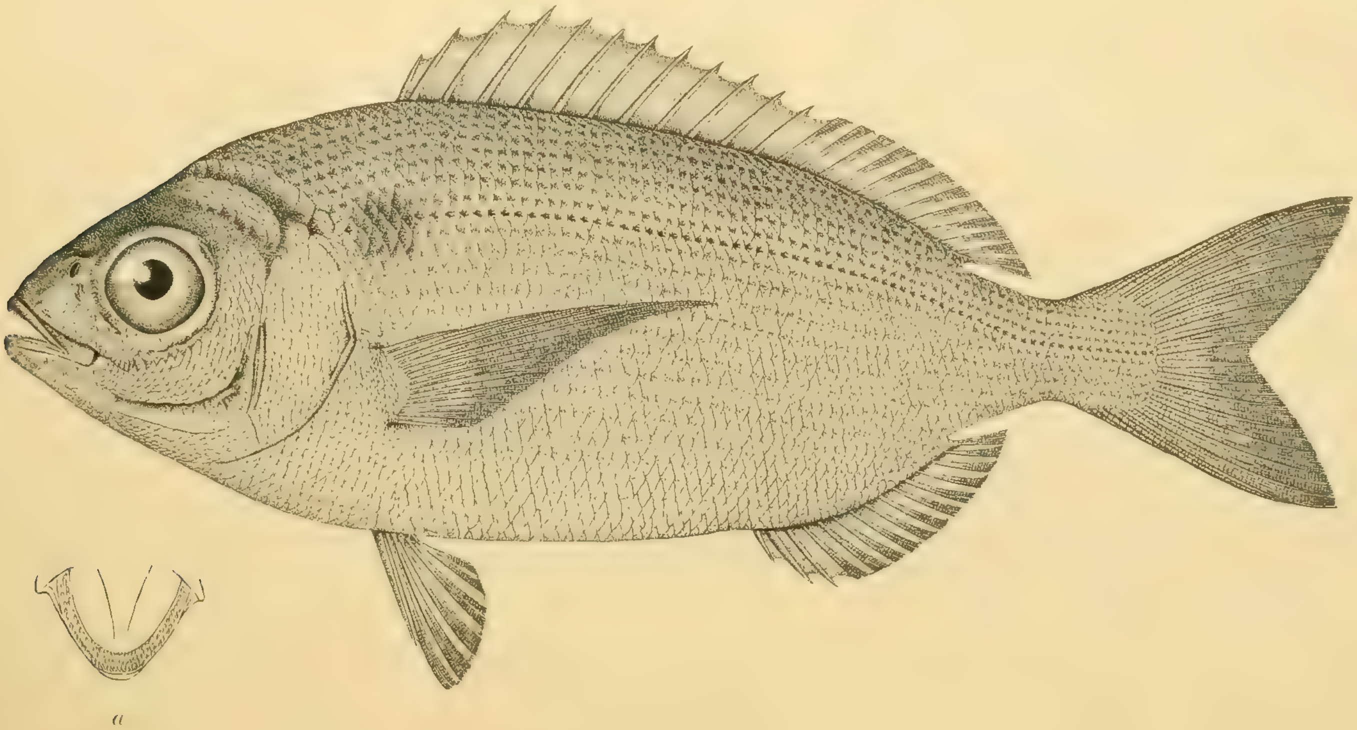

Fig. 16. *Common Sea-Bream* (*Sparus centrodontus*) caught in a flounder-net off Varberg, July, 1886. $^1/_2$ natural size. *a.* mandible with teeth. From a larger specimen. $^3/_4$ natural size.

$R.\ br.\ 6;\ D.\ \frac{12^{a}}{11\text{ l. }12};\ A.\ \frac{3^{b}}{11\text{ l. }12};\ P.\ 2+12+2\text{ l. }2+13+1;$

$V.\ ^1/_5;\ C.\ x+15+x;\ L.\ lat.\ 75^{c};\ L.\ tr.\ \frac{6}{14}+1.$

Syn. *Blanke-Steen*, Ström, *Söndm. Beskr.*, part. I, p. 270; Brünn., *Zoöl. Fund.*, pp. 127 et 137.

Sparus centrodontus, Delaroche, Ann. Mus. d'Hist. Nat., vol. XIII, p. 345, tab. 23, fig. 11; Cuv., Val. (*Pagellus*), *Hist. Nat. Poiss.*, vol. VI, p. 180; Nilss., *Prodr. Ichth., Scand.*, p. 72; Schagerström, K. Vet.-Akad. Handl. 1833, p. 138, tab. 2 et 3; Krøy., *Danm. Fiske*, I, p. 206; Nilss., *Skand. Fn., Fisk.*, p. 115; Gthr, *Cat. Brit., Mus., Fish.*, I, p. 476; Steind., Stzber. Akad. Wiss. Wien, LVI, I (1867), p. 663; Coll., Vid. Selsk. Forh., Christ. 1874; Tillægsh., p. 18; Cederström, Öfvers. Vet.-Akad. Förh. 1876, N:r 4, p. 64; Coll., l. c., 1879, p. 6; Id., N. Mag. Naturv., Christ., Bd. 29 (1884), p. 51; Malm, *Gbgs, Boh., Fn.*, p. 385; Winth., *Zool. Dan.*, *Fiske*, p. 14, tab. III, fig. 2; Id., Naturh. Tidskr. Kbhvn, ser. 3, vol. XII, p. 8; Day, *Fish. G:t Brit., Irel.*, I, p. 36, tab. XIII; Hansson, Öfvers. Vet.-Akad. Förh. 1880, N:r 4, p. 20; Lillj., *Sv., Norg. Fn., Fisk.*, I, p. 214.

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[a] $\frac{12}{13}$ according to Kroyer.

[b] $\frac{3}{11-13}$ according to Steindachner.

[c] 65—70 according to Lilljeborg: 67—70(+ 5—7 on the caudal fin) according to Steindachner.

When full-grown, the Sea-Bream is the largest species within the group *Pagellus*. The specimen taken at Helsingborg and described by Schagerström (l. c.), was 458 mm. long and weighed about $1^{1}/_{4}$ kgm; and Steindachner asserts that he has several times seen in the fish-markets of Spain specimens 630 mm. and upwards in length. The deep form of the body, the depth being about one-third of the length (excluding the caudal fin) is about equally curved on the back and the belly, except at the head, where the downward slope is generally more abrupt than the upward curve of the inferior margin. The greatest thickness of the body is about $^{1}/_{7}$ of the length to the end of the middle caudal rays, is situated near the articulation of the preoperculum and is equal to the height of this bone measured from the articulation to the point in the hind margin where the suture between the suboperculum and interoperculum meets it. The length of the head is 28 or 29 % of the length of the body. The eyes are large, their diameter being greater than the distance between them and the corners of the mouth, but in adult specimens it is equal to or a little less than the breadth of the forehead. Of the two nostrils on each side of the snout the anterior is round and situated at about the middle point in the length of the snout or a little behind it, the posterior oblong and vertical, situated almost on a level with the corner of the mouth. The incisors on the jaws are pointed, and larger on the intermaxillaries than on the mandible (fig. 16, *a*); they form a fairly crowded card, which is continued posteriorly by the two or three (on the intermaxillaries sometimes several) rows of comparatively small, round molars. The operculum is high, but its breadth is less than the diameter of the eye. Of the two occipital branches of the lateral line the posterior is sharply marked as a scaleless, transverse groove, while the anterior forms the boundary between the occiput and the scaly covering of the body. Between them is a patch, generally crescent-shaped, of three or four rows of scales. The lateral line runs fairly parallel to the dorsal edge. In its scales, as in the Black Sea-Bream, appear one or (seldom) two lateral pores above and below the middle pore. The scales of the body are mostly slightly denticulated at the margin, but finely and beautifully granulated on the surface. The length of the pectoral fins is about equal to the length of the head or twice the length of the ventral fins. The base of the dorsal fin, which lies in a well developed fin-groove, occupies about half the length of the body or a little less (excluding the flaps of the caudal fin). The base of the anal fin is about $^{2}/_{5}$ of that of the dorsal. The last ray, like that of the dorsal, is covered by a scaly dermal flap, the extreme continuation of the fin-groove. The longest (third) spinous ray is about $^{2}/_{3}$ (61 or 62 %) as long as the longest (fourth or fifth) spinous ray in the dorsal. The caudal fin is deeply forked; the length of its middle rays is in older specimens about $^{2}/_{7}$ of the length of the upper fin-flap, which is always greater than that of the lower.

The colouring is red, dashed with gray and, on the back, with brown. The sides have a golden and silver lustre, with dark, longitudinal lines along the middle of the rows of scales. The belly is nearly white. The fins are bright red, the ventral being palest, the soft-rayed part of the dorsal with a lighter margin. The black spot on the shoulder at the beginning of the lateral line is absent, according to Couch[a] and Steindachner (l. c.) in young specimens for the first year, until they reach a length of from 7 to 9 inches.

These small specimens without the spot, which are very common on the rocky coasts and in the harbours of Great Britain and are known by a special name (Chads), have never been found on the coasts of Sweden, and thus it is highly improbable that there is any propagation of the species in our fauna. Adult specimens, however, from 35 to 46 cms. long, can scarcely be considered as rare any longer. Since Schagerström described the specimen caught in March 1833, in the Sound off Helsingborg, Malm has recorded the taking of 6 specimens in Bohuslän, and the Royal Museum besides has recently received four specimens from the neighbourhood of Strömstad and Gullmaren. A similar number have been sent to the same museum, which were caught at a depth of from 100 to 250 fathoms in the deep-water channel off the south of Norway. To the last-named district it had already been assigned by Ström (l. c.) on the authority of the fishermen, who even had a separate name, *Blanke-Steen* (Bright-stone), for this species. It has subsequently been met with on several occasions, especially often off Bergen, "both young and adult specimens"[b], and along the south coast from Christiania Fjord as far as north as Trondhjem Fjord.

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[a] *Fish. Brit. Isl.*, vol. I, p. 238.

[b] From this statement of Collett's it would appear that this fish propagates its species off the coast of Norway.

The Sea-Bream's true home is the Mediterranean and the Atlantic outside it: in England and Ireland, too, it is common. In winter it keeps to deeper water, in spring and during summer it approaches the coasts and is met with nearer the surface. Its food consists principally of crustaceans and fish, but also of seaweed. Now and then, when it collects into shoals near the surface, it seems to follow the sardines, and it is sometimes caught in thousands along with these fish. Most often, however, it is taken on night-lines, and the young, which during summer and in autumn crowd into inlets and harbours where the bottom is overgrown with seaweed, are caught on hooks baited with worms, mussels, small fry or bits of fish. According to Risso[a] and Valenciennes (l. c.) it spawns off Nice from May till July. Couch (l. c.), however, found young specimens an inch long on the English coast in January. It is nowhere[b] highly valued as food, I believe, though both Duhamel and Risso eulogized it in their days; but when it can be had perfectly fresh, it is said to be considered tolerably good, even in England.

Fam. MULLIDÆ.

Body somewhat elongate and slightly compressed. External bones of the head unarmed or the hind corner of the operculum produced into a flat spine. Scales large, slightly denticulated, not continued over the dorsal or anal fins. The two dorsal fins quite separate from each other, fairly alike and also resembling the anal fin, which is situated under the second dorsal. System of the lateral line well developed, but without special cavities in the bones of the head. Simple, cylindrical or conical teeth on one of the jaws at least, sometimes on the palate as well. Ventral fins thoracic, with one spinous and five soft rays. Maxillary bone posteriorly membranous and partly concealed by the preorbital bone, when the mouth is closed. Chin furnished with barbels. Branchiostegal rays at most 4. Branched rays in the caudal fin at most 13.

Cuvier[c] was the first to suggest the formation of a separate family for these fishes, but Bonaparte[d] the first to incorporate it in the system.

The Mullets or Sea Barbels — the former name of Latin derivation and explained by the predominant red colouring of these fishes, which reminds one of the red shoes worn by the highest Roman officials[e], the latter from their two barbels, which give them a resemblance to the freshwater Barbels — in their structure come very near the preceding family, especially in the system of the lateral line and the form of the teeth. The former, in its development on the head, closely resembles that of the Sea-Breams. One or two forms of the *Mullidæ*, e. g. of the subgenera *Upeneus* and *Mulloides*, have a covering of scales on the top of the head as far as the snout, up to the point to which the upper branches of the intermaxillaries extend posteriorly. In others, again, as in the true species of *Mullus*, the top and sides of the head are naked throughout the snout, and there, as well as on the preorbital bone, the preoperculum and the branches of the lower jaw, the skin is pierced by pores, one and all, as a rule, with raised, or at least distinctly marked margin and some of them almost as large as the anterior nostrils. These pores also reappear fairly densely on the barbels[f], the feeling organs of the chin, as Winther[g] has also pointed out. Sometimes we may see them, especially clearly on the preorbital bones, as holes in the exterior walls of the underlying, branched canals. In the scales of the lateral line itself the canal is generally divided into numerous, finger-like branches. The teeth, the different occurrence of which on a greater or less number of the jaw-bones or palatine bones formed one of Cuvier's characters for the subgenera, are rather weak on the jaws, generally cylindrical and conical only at the tip or even obtuse. But in some forms we find in the front of the palate, on the vomer, distinct patches of short but strong molar teeth, which remind one of the jaw-molars so common in the preceding family. Furthermore, the granulation of the surface of the scales, and the imperfect development of the teeth at their margin, as well as the large, high preorbital bones, also call to mind the preceding family. There is a considerable difference in the pyloric appendages, however, which in most of the *Mullidæ* are very numerous and sometimes surrounded by a thick coating of fat[a]. The air-bladder, too, in contrast to that of the preceding family, is so rudimentary, in the true Mullets at least, that it is often overlooked[b].

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[a] *Ichth. de Nice*, p. 247.

[b] Cf. Valenciennes (l. c., VI, p. 191) and Day (l. c., p. 37).

[c] Cuv., Val., *Hist. Nat. Poiss.*, vol. III, p. 419.

[d] *Saggio* etc., Roma 1832 = *Versuch einer methodischen Eintheilung der Wirbelthiere mit kaltem Blute*, Uebers. in *Iris* 1833 p. 1205.

[e] Others derive this name from the Greek *μύλλος* — lip; but the Greeks called the Mullet *τρίγλα*.

[f] "La surface des barbillons, vue à la loupe, paraît toute couverte de petits points saillants serrés et fins": Cuv., Val., *Hist. Nat. Poiss.*, vol. III, p. 439.

[g] *Zool. Dan.*, *Fiske*, p. 6.

The Mullets are really ground swimmers, which in an oozy, muddy or loose, sandy bottom root up their food with the snout. Their food consists of crustaceans, worms and mollusks, in search of which they make use of the sensory organs we have just described. Algæ, however, also form a part of their diet. It is remarkable that, just as they usually live at the bottom, we find the caudal fin-rays in the Mullets reduced to the same number as in the Anomalopterous Acanthopterygians, and to some degree justifying the former procedure of uniting[c] into one the genera *Mullus* and *Trigla*. The Mullets, however, are migratory fishes, at certain times of the year at least to be met with nearer the surface, when they are taken in drift-nets even in the open sea; and their resemblance to the preceding family is too strong for us to remove them far from the group of the Perches in our system.

The family belongs principally to the tropic seas, but also to the temperate, and includes about 40 known species, so slightly different in form that they may well be incorporated in one, single genus, the Linnean

GENUS **MULLUS.**

The European representative of this genus has been accepted by CUVIER as the type of a separate subgenus *Mullus*, because *the teeth on the intermaxillary bones, most of them at least, disappear with age.* As we have remarked above, this subgenus is characterized, though not exclusively, by its palatine teeth, which form an oblong patch on the anterior part of the vomer, pointed posteriorly and divided into two by a longitudinal groove. The back of the snout is without scales, the operculum without spines and the air-bladder extremely small.

The subgenus includes only one species,

THE RED MULLET.

MULLUS BARBATUS.

Plate IV, fig. 1.

Colouring of the body red, shading on the back into brown, on the belly into white with or without longitudinal, yellow streaks.

R. br. 4(3); *D.* 8(7) $\frac{1}{8}$; *A.* $\frac{2}{6}$; *P.* 2+15(14); *V.* $\frac{1}{5}$; *C.* x+13(12)+x; *L. lat.* 36—40; *L. tr.*[d] $\frac{2}{6(5)}+1$.

Syn. **Τρίγλα**, ARISTOT.; **Τρίγλη**, ÆLIAN.; *Mullus*, OVID. Cett.; *Mulus*, ISIDOR. (vide ARTEDI).

Mullus minor et *major*, SALVIAN., *Aquat. anim. Hist.*, Romæ 1554, fol. 235, cett.

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[a] According to CUVIER (l. c. p. 452; — after REYNAUD?), however, *Upeneus tæniopterus* from Ceylon has only two pyloric appendages.

[b] Cf. however COSTA, *Fn. Nap.*, *Pesci*, *Triglia* (text) and Plate IX. Also in *Upeneus Vlamingii* and *Up. cinnabarinus* (CUV., l. c., pp. 454 and 475), whereas the air-bladder is large in *Up. tæniopterus*, *Up. flavolineatus*, *Up. zeylonicus* and *Up. maculatus* (CUV., l. c., pp. 452, 458, 459 and 480).

[c] In ARTEDI for example.

[d] Vertically from the insertion of the ventral fins.

Trigla 1 et 2: Art., *Gen. Pisc.*, p. 43; *Syn.*, pp. 71 et 72.

Mullus barbatus, Cicer., *Attic.*, 22; Lin., *Syst. Nat.*, ed. X, tom. I, p. 299; Cuv., Val., *Hist. Nat. Poiss.*, vol. III, p. 442, tab. 70; Gthr, *Cat. Brit. Mus.*, *Fish.*, vol. I, p. 401; Steind., Stzber. Akad. Wiss. Wien, LVI, i, (1867) p. 635; Day, *Fish. G:t Brit.*, *Irel.*, part. I, p. 22, tab. VIII.

Mullus surmuletus, Lin., Syst. Nat., ed. X, tom. I, p. 300; Retz., *Fn. Suec. Lin.*, p. 341; Cuv., Val., l. c., p. 433; Nilss., *Prodr. Ichth. Sc.*, p. 89; Kroy., (*Den guulstribede Mulle*) *Danm. Fiske*, part. I, p. 72; Nilss., *Skand. Fn.*, *Fisk.*, p. 47; Gthr, l. c.; Coll., Forh. Vid. Selsk. Christ., 1874, Tillægsh., p. 17; Malm (*Guldmulle*) *Gbgs*, *Boh. Fn.*, p. 382; Winth., *Zool. Dan.*, *Fiske*, p. 5, tab. 1, fig. 5; Id., Naturh. Tidskr. Kbhvn., ser. 3, vol. XII (1879), p. 7; Lillj., *Sv.*, *Norg. Fiskar*, vol. I, p. 203; Möb., Hcke, *Fische der Ostsee*, p. 34.

Mullus dubius, Malm, Öfvers. Vet.-Akad. Förh. 1852, p. 224, tab. III, fig. 1.

Obs. Salvianus distinguished between the *true* and the *large* Red Mullet; and this distinction, in spite of the protest of Brunnich[a], was preserved by science with Cuvier's sanction, until Günther in his Catalogue (p. 402) declared some doubts of its correctness. Subsequently, Steindachner, in his account of observations made on the fishes of Spain and Portugal, was enabled by a large quantity of materials for comparison to declare this distinction of species untenable. The first-named "species" (*Mullus barbalus, auctt.*) was said to have a more vertical profile owing to the steep slope of the snout from the forehead, and in conjunction herewith the membranous hind margin of the maxillary bones was said to reach farther backwards, some distance behind the perpendicular from the anterior margin of the eye. The larger "species" on the other hand, the *Gold-striped Mullet* (*Mullus surmuletus, auctt.*) was said to have a more elongated snout, and the maxillary bones were said not to extend so far backwards with regard to the situation of the eye. Among 75 specimens, however, Steindachner found that several were intermediate forms that might equally well have been referred to either of these two "species"; and in these specimens the longitudinal, yellow streaks were common to both "species". In the same manner Costa[b], though without acknowledging it, had already come to the same conclusion, for he figured a specimen of *Mullus surmuletus* with the maxillary bones extending considerably under the eyes, and the head of a specimen of *Mullus barbatus*[c] with the snout quite as elongated as in *M. surmuletus*. In two specimens of *Mullus barbatus* (according to Hedenborg) from the Bosphorus, I find the snout of the one, a male, comparatively greatly elongated, and the maxillary bones far from extending backwards to the perpendicular from the anterior margin of the eye, while the snout of the other, a female, is more vertical in profile, and the end of the maxillary bones is almost in the said perpendicular: — in the former the interorbital space is plain, in the latter distinctly concave[d]. Thus no difference of species can well be maintained between these forms. The opinion of Gronovius[e], that *Mullus barbatus* was the male and *Mullus surmuletus* the female of the same species, has also proved untenable[f]: — thus not even a distinction of sex on this ground can be maintained. Still it seems undeniable that the two forms, as such, are generally distinct in nature, — a fact best proved by the circumstance that only the one form has been met with on the coasts of Scandinavia. An explanation of the relation between them seems suggested by the result of observations made on the individual development of these fishes. In the young specimens (fig. 17) described by Malm[g], the profile of the head is almost like that of the Cod; and from this pointed and comparatively long form the interorbital space rises during the growth of the fish, until it reaches the *Mullus*-form. The form most developed in this respect is, therefore, *Mullus barbatus;* but here we are met by the strange fact that it is highly seldom or perhaps never that we find specimens of this form as large as the larger specimens of *M. surmuletus*. Günther[h], it is true, cites one specimen of *M. barbatus* 14 inches in length, which is also the largest measurement given by Willughby[i] for *M. surmuletus*. According to Moreau[j], however, the latter form may attain a length of 400 mm., and Day[k] mentions a specimen, presumably of this form, which was taken at Mevagissey, 17 inches in length. Thus *Mullus surmuletus* must be regarded as a larger form, which has been stunted in the development of one of the strangest outer peculiarities of this genus.

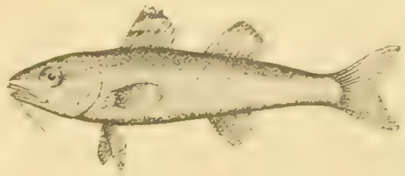

Fig. 17. Young of *Mullus barbatus*. Life size. After Malm.

The body is oblong and slightly compressed, the greatest thickness, as well as the greatest depth, lies behind the head. The greatest depth, which is less than or (in large specimens) equal to the length of the head, varies between 24 and 21 % of the length of the body from the tip of the snout to the end of the middle rays in the caudal fin[l]. The least depth of the body (that of the tail) varies between 9 and 10 % of the length[m].

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[a] *Ichthyologia Massiliensis* (1768) p. 72.

[b] *Fauna del regno di Napoli*, *Pesci*, part. I, (1850) *Triglia*, p. 13, Spieg. della tav. IX, fig. 3.

[c] . . . "perchè se ne distingua la forma comparativamente a quella della T. maggiore": l. c.

[d] Cf. Lilljeborg, l. c.

[e] *Gronov. Cat. Fish.*, ed. Gray, p. 108.

[f] Cf. Steindachner, l. c.

[g] Öfvers. Vet.-Akad. Förh. 1852, l. c. and *Gbgs*, *Boh. Fn.*, pp. 383 & 384.

[h] *Cat.*, l. c.

[i] *Hist. Pisc.* ed. Raji, Oxford 1686, p. 285.

[j] *Hist. Nat. Poiss. Fr.*, vol. II, p. 244.

[k] l. c., p. 24.

[l] Maximum in 5 specimens from 142 to 252 mms. in length 24.2 %
Average .. .. 22.9 %
Minimum .. .. 21.2 %

[m] Maximum .. .. 9.9 %
Average .. .. 9.5 %
Minimum .. .. 8.9 %

The length of the head is between 27 and 24 % of the length of the body[a], and its superior profile slopes more or less steeply, up to (in the so-called *Mullus barbatus*) an angle of about 67° with the inferior profile. The interorbital space is convex or flat, or even concave, the latter condition depending not only on the elevation of the supraorbital margins, but also on a greater development of the two longitudinal ridges on the frontal bones, which run between the supraorbital margins and parallel to each other. The mouth is small and the opening almost horizontal. Of the teeth on the intermaxillaries, which disappear with age, one or two may sometimes be observed still present in adult specimens. The two nostrils on each side are fairly far apart, the anterior being small and round, the posterior forming a more or less vertical slit just in front of the eyes, which are of average size or fairly large. The horizontal diameter of the latter varies between 21 and 24 % of the length of the head[b], or between $5^{1}/_{2}$ and 6 % of the length of the body[c]. The barbels beneath the chin, which may be hidden under the interopercula, extend about as far back as the perpendicular from the hind margin of the preopercula. The branchiostegal membranes are united beneath the isthmus and are extended on 4 rays, the first of which, however, is small and separate from the others, and according to MALM (l. c.) is wanting in young specimens. The operculum and suboperculum each are distinguished, as in the preceding family, by their short extent in the longitudinal direction of the body. The base of the first dorsal fin, *minus* the membrane which connects the last ray with the back, is about equal to that of the second; its distance from the tip of the snout varies between 32 and 34 % of the length of the body[d]. The first ray is extremely small, sometimes scarcely visible externally. The base of the anal fin, which is equal to or a little longer than the least depth of the tail, is about 73 % of the base of the second dorsal[e], half of the length of the pectoral and 10 % of the length of the body[f]. The first ray is so small and so closely united to the second that it may easily be overlooked. The scales of the body are comparatively large and thin. On the cheeks 3 rows of scales, on the interoperculum 1 row, and on the posterior part of the maxillary bones, as a rule, 3 scales. Above the lateral line in front 2 or $2^{1}/_{2}$ rows, farther back 3 or $3^{1}/_{2}$. The colouring of the body is very variable, especially at death. This is the result of the difference in the contraction of the dermal pigment cells. When they are most contracted, the red colour is predominant[g]. At other times the back shades off into brown, the sides into rose and the belly into white. The longitudinal, yellow stripes, which are often wanting or hidden below the red tint, are most distinct in spring, in May, when the spawning-season is at hand[h]. The first dorsal fin, according to MOREAU[i], has, in the so-called Gold-striped Mullet, a bright lilac band at the base, and above that a large, orange spot, and higher up is whitish but crossed by a yellow band with a large, black spot. The second dorsal and the caudal fins are orange: the pectoral a paler yellow. The anal and the ventral of the same colour as the belly, more or less dashed with red and yellow. The fry are described by Malm (l. c.) as grayish green on the back and the upper third of the head, and with this exception glossy silver-white with grayish dorsal fins, the anterior with two oblique, blackish bands, the posterior with one. Our figure is coloured from the specimen (a male) caught by Mr. C. A. Hansson in a mackerel-net on the 6th of August, 1886, at Starekilen in the north of Bohuslän, which, though somewhat damaged, seems to have preserved its colour fairly well, until it was presented by Mr. Hansson to the Royal Museum some time afterwards.

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[a] Maximum in 5 specimens from 142 to 252 mms. in length 26.7 %
Average ,, ,, 26.0 %
Minimum ,, ,, 24.6 %

[b] Maximum ,, ,, 24.0 %
Average ,, ,, 22.8 %
Minimum ,, ,, 21.0 %

[c] Minimum ,, ,, 5.6 %
Average ,, ,, 5.9 %
Maximum ,, ,, 6.2 %

[d] Maximum ,, ,, 34.6 %
Average ,, ,, 33.7 %
Minimum ,, ,, 32.5 %

[e] Minimum ,, ,, 71.4 %
Average ,, ,, 72.7 %
Maximum ,, ,, 73.7 %

[f] Minimum ,, ,, 9.6 %
Average ,, ,, 9.9 %
Maximum ,, ,, 10.7 %

[g] "Desquamato latera rubent, ac si minio vel rubrica tincta forent": WILLUGHBY, l. c.

[h] CUVIER, l. c., p. 439.

[i] *Hist. Nat. Poiss. Fr.*, vol. II, p. 246.

In olden times the Red Mullet was one of the dearest fishes, and appeared only on the tables of rich epicures. "*La Triglia non mangia chi la piglia*" (the Mullet is never eaten by him who catches it), says an old Italian proverb. It was not uncommon, even among Roman citizens, to have to pay for the Mullet its weight in pure silver. Suetonius, in the time of the Emperor Tiberius, mentions three mullets which were sold for 30,000 sesterces (£227). People went so far as to bring these fishes from distant waters and keep them alive in aquaria or ponds until needed for table. "The fishes," says Seneca, "swim at the guests' feet, and they are set under the table so as to be nearer to hand. A Mullet is not considered fresh unless it dies in the guest's hand. They are brought to table in a glass vessel, and the company admire the changes of colour they undergo during the pangs of a long and painful death. Formerly one might hear it said, 'Nothing is better than a rock Mullet,' but now people say, 'Nothing is more beautiful than a dying Mullet; give me the glass dish, that I may watch it struggle and quiver.' When their admiration has exhausted itself in praises, the fish is taken out of the transparent bowl; and now the connoisseurs begin to instruct their more unsophisticated friends. 'Do you see that flame-red colour, livelier than the fairest vermilion, those swelling veins along the sides? One might fancy the belly was blood. Have you observed that azure lustre glowing on its gills?'" This custom had naturally arisen from a desire to enjoy the fish when as fresh as possible, and up to the present day, in order to satisfy the eye, as well as the other senses, of the freshness of this delicious fish, it is scaled alive, the pigment cells of the skin thus becoming convulsively contracted by pain. The taste for this fish has latterly decreased, though it still ranks as one of the best of fishes, on account of its firm, white flesh, which is of good flavour and easy of digestion. The liver is considered the most delicious part, and in the estimation of epicures the head comes next.

The Mullet has about the same geographical range as the Sea Bream — the Mediterranean and the Atlantic outside it. To Sweden its visits are few and far between, but it has several times been taken by herring-fishers off Kullen; and the small fry described by Malm, which were taken on two occasions in Gullmaren, prove that it may propagate its species here. The larger form, the Gold-striped Mullet, is the more common in the Atlantic, being found as far north as the neighbourhood of Bergen, while the smaller, the Red Mullet, is the more common in the Mediterranean and the Black Sea. The species attains its greatest size in the west of the English Channel, according to Couch[a]. Off Yarmouth, too, it is sometimes so plentiful that in one week (in May, 1831) 10,000 are said to have been sent from this town to London. In winter it is taken in deep water with a trawl, in spring it makes for the shore, where it is caught in trammels or with a seine.

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[a] *Fish. Brit. Isl.*, Vol. I, p. 209.

Fam. BERYCIDÆ.

Form of the body oblong or deep, and compressed. Eyes large. Most of the external bones of the head armed, at least during youth, with spines or teeth. Scales large with numerous dentations in the margin, and not extending over the dorsal or anal fin. Simple, pointed cardiform teeth on the jaws and, usually, on the palate. Ventral fins thoracic, with 1 spinous ray and 6 or more soft rays. Branchiostegal rays 8. Branched rays in the caudal fin 15 at least. Most, if not all, of the rudimentary rays at the upper and lower margins of this fin, are spinous.

The *Berycidæ* occupy a peculiar position in the system. Cuvier formed them into a distinct group within the family of the *Percidæ*. In 1837 Bonaparte[a] formed this group into a subfamily, *Holocentrini*, and in 1839 Lowe[b] changed it into a distinct family, *Berycidæ*. Among these fishes we find the Perciform type exhibited in its oldest known forms, as deep-sea fishes with the integument well developed but with a comparatively weak dental equipment of the jaws. In this form they lived as early as the Cretaceous Period. "It is a fact well worth our careful attention," says Agassiz[c], "that these genera are the oldest representatives not only of the *Percidæ*, but also of the whole order of *Ctenoides*. They are, so to speak, the synthetic expression of the whole order at the beginning of its development, and as it appeared before it began to pass through all those changes of form which belong to later times when life appeared in new shapes." One of these traces of earlier times is the large number of rays in the ventral fins, which has generally been reduced in other cases in proportion as the Teleosteous type became marked by the changes of form appearing during the course of its development. Other peculiarities of similar significance appear, however, in special forms of the *Berycidæ*. One of them we find in the connection, pointed out by Cuvier[d], in the genus *Myripristis* between the air-bladder and the hearing-organ in the skull, and also the contraction of the air-bladder into an anterior and posterior part, points which are now most general and most strongly developed in the *Siluridæ*, *Cyprinidæ* and *Characinidæ*, all three of which are to be reckoned among the less advanced developmental stages of the Teleosteous type. Another of these peculiarities is the preservation of the pneumatic duct, a Physostomous character observed by Kner[e] in the genus *Holocentrum* of this family.

The family includes about 60 species distributed among 5 or 6 genera, and principally belonging to the tropic seas. As in the preceding family, red is the predominant colour of the body. To the Scandinavian Fauna we can only assign one species of the

Genus BERYX.

Only one dorsal fin, with the spinous-rayed part shorter than the soft-rayed[f]. *Cardiform teeth on the jaws, the vomer and the palatine bones.*

This genus, which has given its name to the family, is the oldest belonging to it and therefore presumably shows us the nearest approach to the original type. The body is fairly high, strongly compressed laterally, and thickest at the head, with fairly lobate pectoral fins and both dorsal and anal fins displaying a striking likeness of structure to the respective flaps of the caudal fin, being anteriorly supported by spinous rays gradually increasing in length but shorter than the first soft rays. Another peculiarity lies in the fact that the dorsal part of the large lateral muscles extends over the occiput and the top of the head, and has its anterior starting points on the forehead, just above the eyes, while in the other, younger genera of the family the posterior parts of the head are naked and have their osseous covering adorned and strengthened by raised ridges and bars, essentially corresponding to those we have seen in *Polyprion* and, to some extent, in *Perca*, but longer, more crowded and sharper. Among the other bones of the head, in *Beryx* too, the preoperculum, the interoperculum, the nasal bones, the naked part of the frontal bones, the upper part of the maxillaries and the branches of the mandible are well furnished with serrate teeth at the margin or on the ridges which cross their surface. The preorbital, nasal and frontal bones (the latter just above the eyes) are furnished with spines, which are sometimes branched, and disappear or at least diminish with age.

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[a] *A new Systematic Arrangement of Vertebrated Animals*, Trans. Lin. Soc., vol. XVIII, p. 297, — printed in 1840.

[b] *Suppl. Syn. Fish. Mad.*, Trans. Zool. Soc., vol. III, p. 1, — published in 1849.

[c] *Rech. Poiss. Foss.*, tome IV, p. 115.

[d] Cuv., Val., *Hist. Nat. Poiss.*, vol. III, p. 168.

[e] Stzber. Akad. Wiss. Wien, XLIX (1864), I, p. 457.

[f] In other cases — in the younger types of the family — the spinous-rayed part of the dorsal is generally distinct as an anterior fin, and is longer than the soft-rayed part, which is of about the same degree of development as the anal fin.

The genus inhabits the abysses of the Atlantic and Pacific Oceans, forming one of the many traces of the partial survival of the Cretaceous Period in the life of the present deep-sea fauna[a]. It is taken in Australia more often than in any other country, though even there only occasionally and by fishermen engaged with other fish, and the flesh of one species is there prized as one of the greatest delicacies[b]. The number of existing species, according to GÜNTHER (*Cat.*, l. c.) is 5, but our ignorance of the changes in these species which are due to age, is a strong ground for doubt as to the correctness of all of them. From the Cretaceous Period AGASSIZ (l. c.) cites 5 known species, and since his time 3 more have been described[c].

BERYX DECADACTYLUS.

Fig. 18.

Spinous rays in the dorsal fin only 4, soft rays over 15. Greatest depth of the body from 43 to 45 % of the length from the tip of the snout to the end of the middle rays of the caudal fin. Colour of the body on the head and the back down to the lateral line, as well as all the fins and the spines of the head, bright red, towards the belly shading into light silver with a reddish lustre. Eyes wine-yellow, transparent as glass.

R. br. 8; *D.*[d] $\frac{4}{18-19}$ *A.*[e] $\frac{4}{27-29}$; *P.*[f] 2 + 14; *V.*[g] $\frac{1}{10}$;
C.[h] $x + 17 + x$; *L. lat.*[i] 67; *L. tr.*[j] $\frac{11}{20} + 1$.

Syn. *Beryx decadactylus*, CUV., VAL., *Hist. Nat. Poiss.*, vol. III, p. 222; GTHR, *Cat. Brit. Mus.*, *Fish.*, vol. I, p. 16; STEIND., Stzber. Akad. Wiss. Wien, LVI (1867), I, p. 603, tab. I.
Urocentrus ruber, DÜB. et KOR. (per DÜBEN) Öfvers. Vet.-Akad. Förh., 1844, p. 111.
Beryx borealis, DÜB. et KOB., Vet.-Akad. Handl. 1844, p. 35, tab. II, fig. 1 et 2; NILSS., *Skand. Fn.*, *Fisk.*, p. 37; COLL., Vid. Selsk. Christ. Forh. 1874, Tillægsh., p. 14; LILLJ., *Sv.*, *Norg. Fn.*, *Fisk.*, vol. I, p. 76; COLL., Vid. Selsk. Christ., Forh. 1884, No, 1, tab. I.

Obs. Amongst the booty taken by the French from Lisbon, when Napoleon I caused the treasures of the Portuguese Museum to be conveyed to Paris, was a dried specimen of this species, with no locality assigned to it, which was described and named by CUVIER.

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[a] Cf. SMITT, *De senaste årens undersökningar om hafsfaunans gräns mot djupet*, in the Magazine *Framtiden*, Vol. III, (1870), p. 335.

[b] TENISON-WOODS, *Fish. a. Fisher, N. S. Wales*, Sydney 1882, p. 51.

[c] PICTET: *Tr. de Paléont.*, vol. 2, p. 50.

[d] *D.* $\frac{4}{16-19}$ according to GÜNTHER.

[e] *A.* $\frac{4}{27-30}$ according to STEINDACHNER.

[f] *P.* 2 + 15 according to STEIND., 1 + 15 according to COLLETT.

[g] *V.* $\frac{1}{9-10}$ according to STEIND.

[h] *C.* $x + 18 + x$ according to v. DÜBEN et KOREN and LILLJEBORG.

[i] *L. lat.* 60—62 according to STEIND., 64—65 according to GTHR.

[j] *L. tr.* 34—35 according to GTHR, $\frac{10-11}{21-22}$ according to STEIND., 30—31 according to LILLJEBORG.

That this species coincides with *Beryx borealis* of v. Düben and Koren, was evident when Lowe[a] and Steindachner[b] described fresh specimens of the former species. A comparison drawn between the classical description of v. Düben and Koren and the diagnosis of the species given by Steindachner, leaves no room for further doubt as to the identity of the species, least of all if we observe the significance of the changes due to age (the reduction of the spines etc.), which we see in other species of the family. Anyone who will reduce the measurements of different parts of the body given by v. Düben and Koren to the corresponding percentage of the greatest depth of the body, will find the same proportions in Steindachner's figure, in some respects corresponding in the minutest details. The identity of species was also clearly shown by the well-founded remarks of Lilljeborg and the later comparison between specimens of *B. decadactylus* and the type specimen of *B. borealis*, a comparison which was executed by Collett. However, one question connected herewith is still unsolved. If one examines the characters for *Beryx splendens* given by Lowe and Steindachner — the lower form of body, the comparatively straight back, the short base of the dorsal fin, the long pectoral fins, the large eyes, the smaller number of soft rays in the dorsal fin[c] and the occasional increase in the number of rays in the ventral fins, if one pays attention to the complete similarity of colouring in the two "species," remarked by Steindachner, to the fact that *B. splendens* was assumed to be of smaller size[d], and lastly to the fact that both species are said to occur with complete identity in two regions so distant as the Atlantic and Japan, then it is evident that there are sufficient reasons for the surmise that a still further reduction of the number of species within the genus is at hand. While we are considering this point, an examination should also be made in the same way of the relations between *Beryx affinis* and *B. lineatus*.

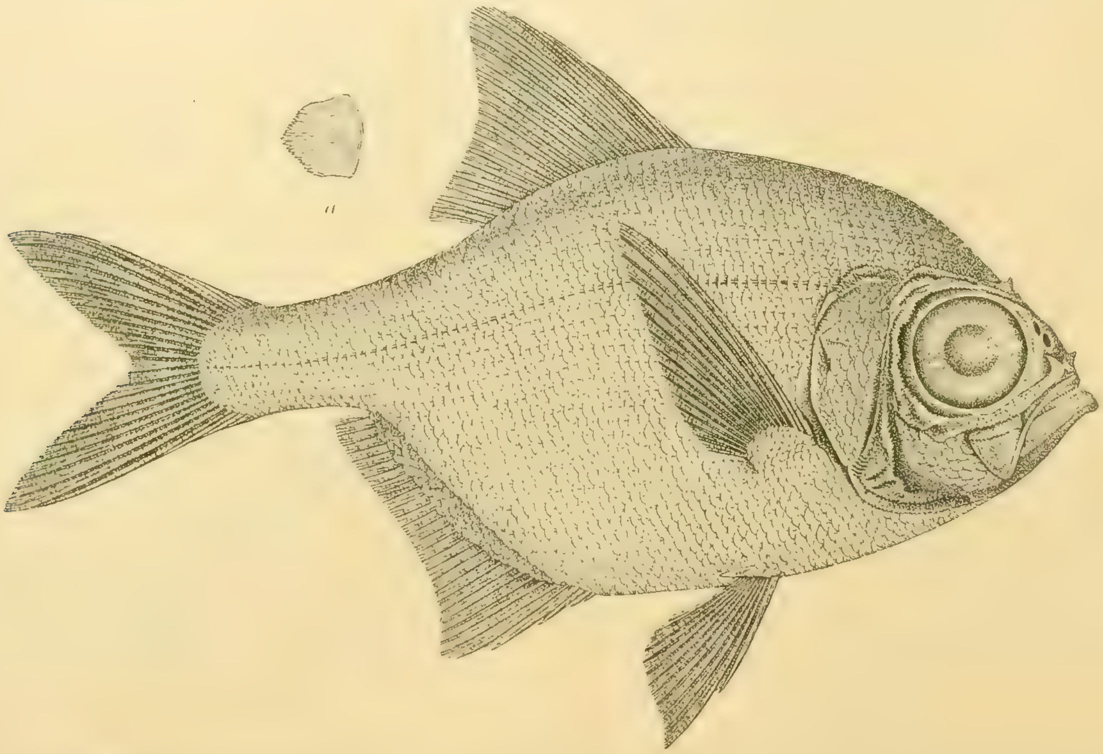

Fig. 18. *Beryx decadactylus* from Bergen. 1/2 nat. size. After v. Düben and Koren. *a:* a scale; after Steindachner.

The most remarkable points in the form of the body in *Beryx decadactylus* are given above. There seems to be a very important change in form due to age, which starts from the rhomboidal form described by v. Düben and Koren, with "the forehead and the anterior part of the back parallel to the base of the anal fin, and the posterior part of the back parallel to the lower jaw and the anterior part of the ventral line." The peduncle of the caudal fin is narrow, its least depth being less than the diameter of the eye, which is perfectly circular, and both in v. Düben's and Koren's measurements and in Steindachner's figure it is exactly $^1/_4$ of the greatest depth of the body. The upper margin of the dorsal fin, like the lower of the anal, is concave, and the hind margin of the caudal fin is still more deeply forked. The pectoral fins are pointed and directed obliquely upwards; in the older specimens they seem comparatively shorter and more obtuse than in the younger ones. To the reduction of the spines of the head which generally appears with age — the branched preorbital spines are those which still remain longest and strongest, while the spines on the nasal bones and on the forehead between the eyes almost disappear, and the spine at the lower posterior corner of the branches of the lower jaw becomes insignificant — we must also assign the almost complete disappearance of the bony ridge on the operculum, which in several of the preceding forms we have seen prolonged into a spine at the hind margin. It should also prove interesting to examine some young specimens in order to see whether the two "sharply denticulated ridges" which occur at the rounded corner of the preoperculum, do not correspond in their development to some evanescent spines on the same bone. The dentation of the scales of the body seems also to undergo a completely analogous diminution as the fish grows older. Their free surface, above and below the longitudinal groove, is fringed in youth with from 16 to 20 or more rows of spines, which afterwards change into denticulated ridges and finally into still smoother bars, a difference which may also be observed to exist between the scales of the back and cheek and those of the belly. All these changes indicate that *Beryx*, though one of the oldest generic forms and though it retains the original type of the family in some respects, has still passed through changes of form which mark such stages of development as other, apparently younger genera, e. g. *Holocentrum*, have never surmounted.

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[a] Trans. Zool. Soc., vol. III, p. 1.

[b] Stzber., l. c.

[c] According to Günther the variation is between 15 and 16.

[d] Though Steindachner mentions a specimen of *B. splendens* 397 mm. in length and thus about 1 decim. longer than the smallest known specimen of *B. decadactylus*, this proves no more than that here, as in many divisions of the system, juvenile characters may sometimes be retained excessively long.

Beryx decadactylus, which attains a length of about 52 cm., is one of the rarest of fishes, not only in Scandinavia, where only 3 specimens have been found and these confined to the neighbourhood of Bergen and taken at a depth of 200 fathoms, but also in the deep water between the Canary Islands, Madeira, the Azores and Portugal, the other locality where it has been met with in the Atlantic. There is a significant peculiarity, however, in connection with its geographical range, not only that it thus lives in so far distant parts of the Atlantic, a proof of the fact that the deep-sea fauna is uniform and made up of hardy, primitive forms, but also that it forms a connecting link between the fauna of the Mediterranean region and the Sea of Japan. Döderlein and Steindachner include this species[a], together with *B. splendens* among the fishes of Japan. As an explanation of this find and other similar ones, Günther's[b] remark as to the still more remarkable range of certain shore fishes must not be forgotten[c]: "Bold as the hypothesis may appear, we can only account for the singular distribution of these shore-fishes by assuming that the Mediterranean and Japanese seas were in direct and open communication with each other within the period of the existence of the present Teleosteous fauna."

SCOMBROMORPHI.

A fusiform body with a narrow (low), round peduncle of the caudal fin, a skin often naked or only partly covered with thin, cycloid scales, a weak dental equipment of the mouth, no denticulation of the preoperculum in adult specimens, weak spinous rays in the dorsal and anal fins and pointed (typically falciform) pectoral fins and caudal flaps form the general distinctions between the series of the Mackerel and Perch families. But the former, as well as the latter, in contradistinction to the Anomalopterous families, are *stenobrachii* and furnished with numerous rays in the caudal fin (*euryripidi*).

We have already seen the principles on which a series of the Acanthopterygian Teleosteous families might be grouped round the Mackerel-form as their type. But there are important deviations from this type within the series itself. Sometimes the body is naked, sometimes covered with large scales; sometimes it is long and low, sometimes high and compressed; but these different forms are systematically connected, partly by changes of development (growth) and partly by intermediate forms even in the same family. The character which may most generally be employed, is one that in other cases where the distribution is so wide, is scarcely applicable, namely, the sharp-pointed form of the feebly-supported fins, especially the pectoral and caudal. But even this character must lose its validity where the history of development conjoins an obtuse-finned form with the sharp-finned types. Another character which generally holds good, is the narrow and round peduncle of the caudal fin. The singularly characteristic bars on the sides of the peduncle which occur in many forms of the Scombromorph series, may also serve on occasion as clues to their distinction from the series of the Percomorph families. Thus, for example, one species of the genus *Brama*[a] possesses such bars on its tail indicating the right place of the genus and the family, while the other forms of the *Bramidæ* are without it.

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[a] Denkschr. Akad. Wiss. Wien, Mat. Naturw. Cl., Bd. XLVII, pp. 220, 221.

[b] Provided it cannot be proved that both these "species" are cosmopolitan deep-sea fishes.

[c] *Introd. Study of Fish.*, p. 270; *Handb. Ichthyol.*, p. 181.

With the exception of the *Zenidæ* and *Capridæ* and the addition of Gill's *Acronuridæ*, the series of the Mackerel families, as defined here, corresponds to the *Scombroidæ* of Gill[b]. Günther combined this series with that of the Cottoid families into a group which he named *Cotto-Scombriformes*, with the remark that the true Cottoid genera exhibit forms of transition to the Mackerel type[c]. It is certainly true that this opinion finds support in the known changes of development, in the Sword-fishes, for example, where the armoured head of the young specimens reminds us of the Trigloid type, or in the diminution of the size of the ventral fins which is very common among the *Scombromorphi* and gives the juvenile forms a close resemblance to the aforesaid type in this respect too. But the Anomalopterous characters we have given above, sharply divide the Cottoid type from the Mackerels.

Of the Scombromorph families the Scandinavian Fauna possesses 5, which may be distinguished in the following manner:

I: Soft rays of the ventral fins 5 at most. Intermaxillaries and mandible, at least, armed with teeth in adult specimens, though these teeth may disappear in extreme old age.
  A: Scales of the body in Ganoid manner connected by processes from their basal part. Lateral line scarcely visible; its scales hardly distinguishable from the other scales of the body .... *Bramidæ*.
  B: Scales of the body separate from each other, thin and cycloid, where they exist. Lateral line distinct.
    1: Before or at the beginning of the anal fin two spinous rays, which may, however, become indistinct or even disappear with age. Longitudinal ridges of the bony skull high and long; occipital ridge continued on the surface of the coalescent frontal bones .... *Carangidæ*.
    2: No spinous rays or only one before or at the beginning of the anal fin. Longitudinal ridges of the bony skull comparatively low and short; frontal bones without central ridge.
      a: Upper and lower jaws about equally projecting .... *Scombridæ*.
      b: Upper jaw prolonged projecting "like a sword" over the point of the lowerjaw *Xiphiidæ*.
II: Soft rays of the ventral fins more than 5. Jaws without teeth, in adult specimens................. *Lampridæ*.

Fam. **BRAMIDÆ.**

Form of the body high or elongated, strongly compressed. Eyes large or of average size. Of the external bones of the head only the preoperculum, and this only in youth, dentated at the margin. Scales large or middle-sized, cycloid, high on the sides of the body (especially during youth), *above and below continued by processes, which in certain parts of the sides at least, serve to connect the rows of scales. Spinous-rayed part of the dorsal and anal fins little developed. Supporting rays of the caudal simple and spinous. Simple, pointed teeth, arranged in a card, on the intermaxillaries and lower jaw at least. Ventral fins thoracic* (sometimes jugular) *with one spinous ray and 5 soft*[d]. *Branchiostegal rays 7. Branched rays in the caudal fin 14 at least* (*?*).

Following Gill's example[e] we make the genera *Pteraclis*, *Pterycombus* and *Brama* into a family distinct from the family *Coryphænidæ* as formed by Lowe[f] and afterwards adopted by Günther[g].

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[a] *Brama princeps* (from Madeira), Johnson, Proc. Zool. Soc. 1863, p. 37; = (?) *Br. longipinnis* (see below).

[b] *Arrang. Fam. Fish.*, Smith's Misc. Coll., No. 247.

[c] "The true Cottoids gradually pass into the Scombroids proper": *Cat. Brit. Mus., Fish.*, vol. III, App., p. VI. No less clear, however, is the systematic transition, through the *Squamipinnes*, between the families of the Scombromorph and Percomorph groups.

[d] *Pteraclis*, however, is abnormal in this respect and has its ventral fins reduced even in the number of rays.

[e] l. c. Cf. Jordan et Gilbert, *Syn. N. Am. Fish.*, Bull. U. S. Nat. Mus., No. 16, p. 455.

[f] *Fishes of Madeira*, Introd., p. XII.

[g] *Andr. Garr. Fische der Südsee*, p. 146; *Study of Fishes*, p. 452; *Handb. Ichthyol.*, p. 319.

CUVIER[a] and BONAPARTE[b] referred *Brama* to the 'scale-finned' fishes (*Squamipinnes* or *Chætodontidæ*) and *Pteraclis* to the *Scombridæ*, each genus, however, in its own subfamily (*Bramini* and *Coryphænini*). But LÜTKEN, to whom belongs the merit of having first given an explanation of the changes of age within the family[c], maintains the near relationship between *Pteraclis* and the other members of the family, which he unites in the "Sub-group *Bramidæ*." That the high and comparatively short, large-scaled *Brama*-type has been combined with the elongated and small-scaled type of the *Dorades* (*Coryphæna*), is an echo of CUVIER's remark as to the analogy in the structure of the skull between *Brama* and *Coryphæna*, an analogy which may also be extended, however, to the *Carangidæ*. But that CUVIER was still justified in uniting *Brama* with the scale-finned fishes, is an expression of the natural relationship which also exists between the great series of the Scombroid and Percoid families. Here, in the Bramidæ, this relationship has its expression in a family type which is probably very old, even from a geological point of view, in spite of the fact that as yet we know of no fossils of this family. In their covering of scales the *Bramidæ* display one of the most distinct traces of the oldest Teleosteous forms, which amounts even to an explanation of the so called 'dermal ribs' or 'pleurolepidal lines'[e] of the Pycnodont fishes, as the scales, in *Pterycombus* as well as *Brama*, but most clearly in the former, repeat the structure described by AGASSIZ, EGERTON and WAGNER, and afterwards employed by LÜTKEN as a character for the "series" *Lepidopleurini* or *Pycnodonta* (fig. 19) and by GÜNTHER for the "suborder" *Pycnodontoidei* among the Ganoids. CUVIER[f] described, and COSTA and LUNEL[g] both described and figured this structure of the scales in *Brama;* and we find it still more complete in *Pterycombus brama* (fig. 20). There too, the scales are of very dissimilar forms on different parts of the body, but if we follow these dissimilar forms from the dorsal edge downwards in a transverse row, we find them all alike in one respect, namely, that the hind (uncovered) part of each scale is thin, covered with fine striations longitudinally radiating in the direction of the body, and pierced by irregularly distributed, round,

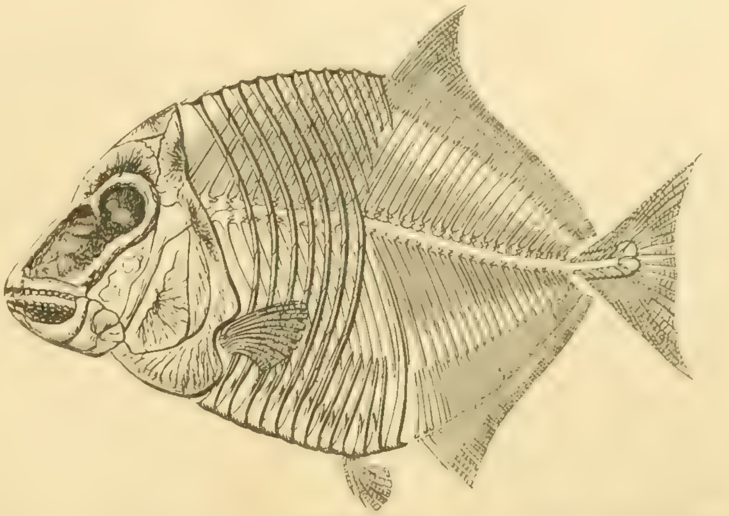

Fig. 19. Sketch of a Pycnodont from the Jurassic period. From LÜTKEN's treatise on the distinction and division of the Ganoids.

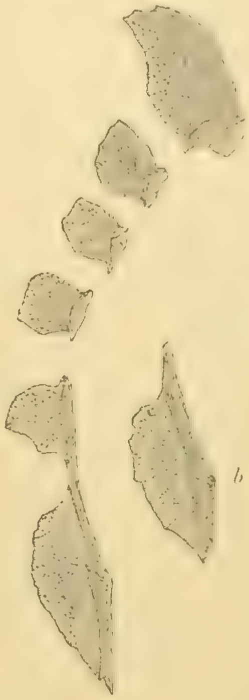

Fig. 20. From the first to the sixth scale, together with the scale of the lateral line (*b*) in a transverse row from the back to the middle of the side, in *Pterycombus brama*. Half as large again as the natural size.

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[a] CUV., VAL., *Hist. Nat. Poiss.*, vol. VII, p. 281 and vol. IX, p. 359. Cf. also CUV., *Règn. anim.*, éd. 2, tom. II, pp. 194 and 216.

[b] Isis, 1883, pp. 1207 and 1209.

[c] *Spolia Atlantica*, l. c. p. 491. Cf. too GÜNTHER, *Cat. Brit. Mus., Fish.*, vol. II, pp. 408 to 411.

[d] CUV., VAL., l. c., VII, p. 291.

[e] AGASSIZ, *Poiss. Foss.*, vol. II, part. 2, p. 184, tab. 67; 68; 69, fig. 2 et 3; 69, b; 69, c. EGERTON, Quart. Journ. Geol. Soc. Lond., vol. V. part. I, p. 330. WAGNER, Abh. Math. Phys. Cl. Akad. Wiss. München, Bd. VI, Ahth. I, pp. 8 to 10. LÜTKEN, *Gan. Begr., Indd.*, Vid. Meddel. Naturh. For. Kbhvn. 1868, p. 48 (sep.) and Geol. Mag. vol. V (1868). GÜNTHER, *Study of Fishes*, p. 366; *Handb. Ichthyol.*, p. 254.

[f] CUV., VAL., *Hist. Nat. Poiss.*, vol. VII, p. 289.

[g] COSTA: *Fauna del regno di Napoli*, *Pesci*, parte prima, Acantotterigii Squamipenni, pp. 13 etc. tab. LII. LUNEL: *Rev. Castagne.*, Mém., Phys. et D'Hist. Nat. Genève, Tome 18, pp. 174 and 188, pl. I, fig. 1, b — 1, f; pl. II, fig. 1, b — 1, e.

pores. and also that the anterior part of the scale (covered by the skin) is of a somewhat stronger structure, and separated from the other part by a sharp, double curve, which bends first inwards and then as sharply forwards (in the direction of the body). The fine striations are continued on the curve, but the inmost part of the scale is crossed by transverse, thickening lines. The dorsal *fin-covers* (the scales forming the groove into which the dorsal fin may be depressed) are in one respect irregular — the curve is knee-formed, so that it extends both over the anterior and inferior parts of the scale, the free part of which thus becomes the superior-posterior. In a downward, transverse row from one of these 'fin-covers' we first find small scales with the free part rounded or emarginate at its posterior edge, and also divided at the circumference from the anterior part of the scale by an incision in the upper and lower margins. In front of this incision the anterior (covered) part of the scale projects in a shorter (upward) or longer (downward) process. It is these processes, with the thickening lines mentioned above, that at the middle of the side of the body are so elongated that the one scale is joined in synarthros by its inferior process to the superior process of the scale next in order below it. When we add to this the externally visible elevation (transverse elongation) of the whole scale in the rows at the middle of the body, it is evident that if the thin, posterior (free) part of the scale were taken away, we should find rib-like formations in the integument, exactly like those described in the Pycnodonts, a Ganoid group which existed from the Carboniferous period to the beginning of the Tertiary, and to which the Bramidæ have no further relationship than the sometimes striking likeness in the form of the body and the vertical fins.

Our knowledge of the *Bramidæ* is as yet comparatively scanty. They are deep-sea fishes, all presumably of wide geographical range. The principal distinctions between the two genera which belong to the Scandinavian Fauna, are given in the following scheme:

1: The row of scales at the extreme dorsal and ventral edges along the base of the dorsal and anal fins, consists of high scales (*fin-covers*), which are so arranged, that they form a deep groove, in which these fins, which are otherwise without scales, may be sunk .... *Pterycombus.*
2: No fin-groove. Dorsal and anal fins covered with scales .... *Brama.*

GENUS PTERYCOMBUS.

The dorsal fin begins at the occiput, vertically above the posterior orbital margin. The anal fin begins behind the perpendicular from the insertion of the pectoral fins. The longest rays of the first named fins measure less than the greatest depth of the body. Fin-covers large, from 50 to 53 pairs at the base of the dorsal fin and about 40 at that of the anal. Eyes large; diameter of the orbit nearly half the length of the head. Palate without teeth.

At the first glance the extent of the dorsal and anal fins seems to be the clearest distinction between this genus and *Pteraclis*, particularly as in adult specimens of the latter genus these fins are considerably higher, especially in comparison with the depth of the body, which is lower and has smaller fin-covers. But in youth, according to LÜTKEN (l. c.) *Pteraclis* bears a much closer resemblance to *Pterycombus* and has a higher form of body and lower fins.

Of the latter genus only one species is known.

PTERYCOMBUS BRAMA.

Fig. 21.

> *"Silver-white, somewhat darker on the back, with the dorsal, anal, and ventral fins blackish and the pectoral light yellow."* LILLJEBORG.

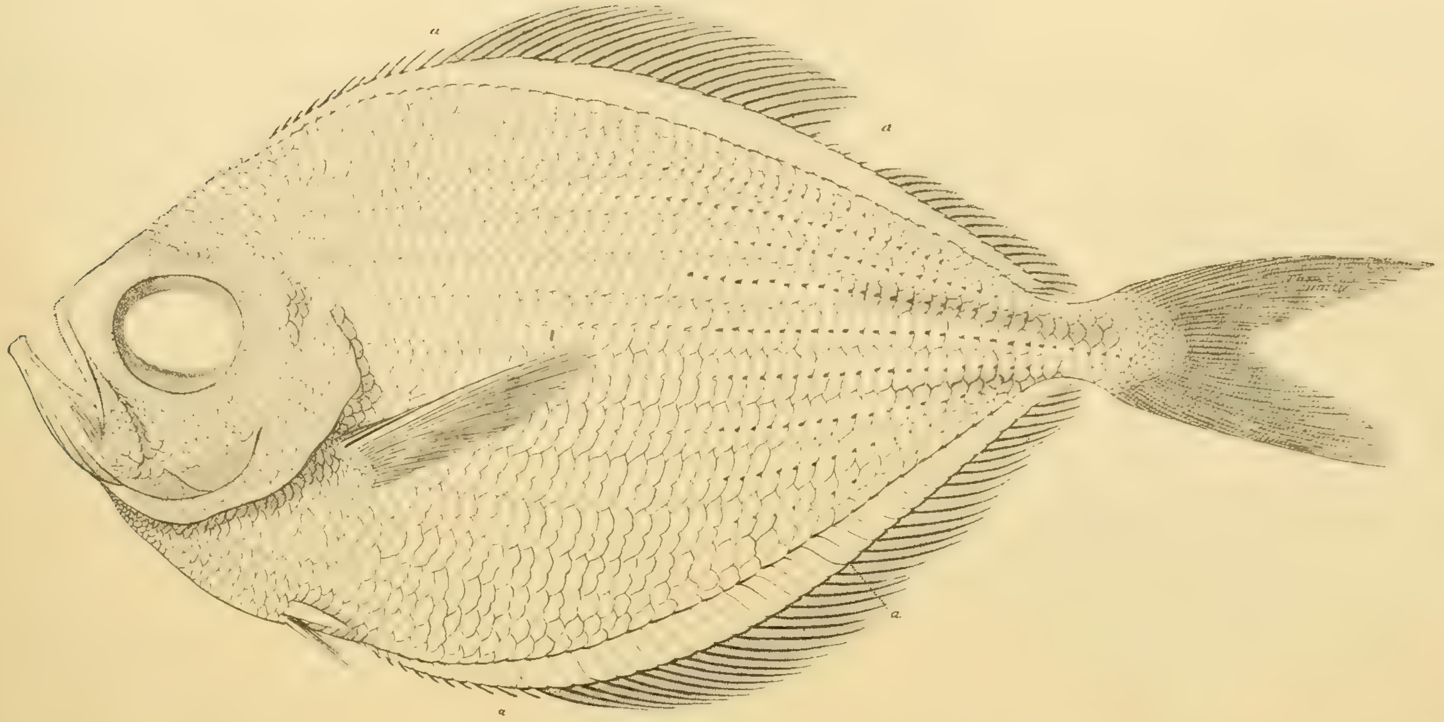

Fig. 21. *Pterycombus brama* from Hammerfest. $^{1}/_{2}$ natural size. After FRIES and v. WRIGHT.

R. br. 7; *D.*[a] 9 + (42—44); *A.* 3 + (37 -40); *P.* 2 + 19; *V.* $^{1}/_{5}$; *C.* 20; *L. lat.* 49.

Syn. *Pterycombus Brama*, FR., Vet.-Akad. Handl. 1837, p. 15, tab. II; NILSS., *Skand. Fn., Fisk.*, p. 125; LILLJ., *Bidr. känn. Pt. br.*, Ups. Univ. Festskr. 4 Nov. 1864; ESM., Forh. Skand. Naturf. Möde, Christ. 1868, p. 522; COLL., Vid. Selsk. Forh. 1874, Tillægsh., p. 47; ibid. 1879, p. 30; LÜTK., *Spol. Atl.*, Kbhvn. Vid. Selsk. Skr., ser. 5, vol. XII, p. 501, tab. IV, fig. 4; LILLJ., *Sv., Norg. Fiskar*, I, p. 291.

Obs. We have had at our disposition only two dried specimens, which are in several respects incomplete. The one, the property of the Royal Museum and described by FRIES, was brought by Captain BISMARK in 1834 from Hammerfest in Norway, the other, somewhat smaller — about 301 mm. in length from the tip of the snout to the end of the middle caudal rays — and also from Finmark, was kindly lent by the Zoological Museum of Upsala University. We have therefore thought it best to reproduce v. WRIGHT's careful figure of the former specimen, even with the imperfections that naturally affect it.

The specimen described by FRIES measured 384 mm. from the tip of the snout to the middle rays of the caudal fin, when it came into his possession, and the greatest depth of the body was 198 mm. The greatest thickness, measured across both opercula, was 55 mm. Length of the head 100 mm. Orbital diameters, which are exactly alike, 42 mm. The depth is thus about half the length; the thickness about $^{2}/_{7}$ of the depth; the length of the head about $^{1}/_{4}$ of the length of the body, and the diameter of the orbit $^{1}/_{9}$. Length of the lower jaw 62 % of the length of the head, and somewhat over 16 % of the length of the body. The length of the intermaxillary and maxillary bones, from the tip of the snout to the upper posterior corner of the latter bones, measures 58 % of the length of the head. Interorbital region 27 % of the length of the head, and the least depth of the body (the least depth of the tail) 24 %. For other particulars we may refer to the figure.

Both jaws are furnished with small, fine, pointed teeth, which curve inwards and are set partly in regular and partly in irregular rows: in the mandible they are apparently set in two rows, an outer one, which ends half-way along the jaw, and an inner one with larger teeth, especially in front, which extends along its whole length, but between these rows, in the front part of the mandible, there are several teeth of similar form but in no regular arrangement. In the upper jaw, on the intermaxillary bones, the teeth are similarly arranged in an inner and an outer row with several teeth between them, but posteriorly both rows converge and at last join into one, single row. There are no teeth on the palatine bones, the vomer or the tongue.

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[a] Number of rays in *D.*, *A.* and *C.* according to LILLJEBORG.

As in the rest of the *Bramidæ* and as we have already seen in *Beryx*, the dorsal parts of the large lateral muscles originate as far forward as the forehead just above the middle of the orbits. In front of this point the forehead and snout are convex, with a depression along the middle and with the skin pierced by a number of pores like those we have above described in the *Sparidæ*. The anterior nostrils are oval and situated almost half-way between the point of the upper jaw and the anterior orbital margin, the posterior appear like slits and are situated lower than the anterior, about half-way between them and the orbital margin[a].

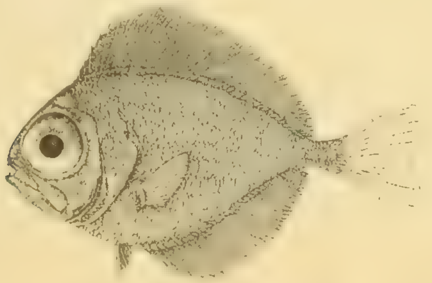

Fig. 22. Young of *Pterycombus brama* from the middle of the Atlantic. Twice the natural size. After LÜTKEN.

In adult specimens the operculum and the other bones belonging to the apparatus of the gill-cover are completely destitute of armour; but during youth the margin of the preoperculum is dentated in the manner shown in LÜTKEN's figure, which we reproduce here (fig. 22) and which is presumably that of a young specimen of this species. In the dried specimen the hind margin of the operculum is somewhat undulating, with one of the projections longer than the others. The gill-aperture is complete and open as far down as the point of the isthmus.

The head is entirely covered with scales, with the exceptions mentioned above, namely the snout, the intermaxillaries, the lower margin of the preoperculum, and the lower jaw, along which we find raised bars as in the *Berycidæ*.

The most special characters of this fish are the peculiar formation of the scales and the groove in which the dorsal and anal fins are set. The body is covered with large, imbricate, very thin and broad (high) scales, which form regular longitudinal rows. The free part of each scale is almost square (see fig. 20, p. 71): the *inner* or basal margin is straight and furnished at the middle with a small, raised knob, which towards the tail gradually develops into a short, stiff spine, while the *outer* or hind margin is rounded or bilobate, with the lobes separated by a small incision which receives the spine of the scale behind. These spines are nothing more than convexities of the scales themselves. The lateral line, which is not distinguished by the form of its scales from the other rows of large (high) scales, contains from 49 to 51 scales, the anterior without distinct spines. The canal of the lateral line pierces the inner (covered) part of each scale (fig. 20, *b*) about half-way up, and just behind the spine or the corresponding knob sends out a small, opening duct on the outside of the scale in an oblique, upward direction: on the inside of the scale the canal is continued in a tubular form as far as the scale is attached to the skin, where it ends, to be continued at the anterior margin of the scale next behind. The lateral line occupies the third row of high scales incised at the hind margin, and between these rows and the dorsal fin-covers there are anteriorly 5 rows of smaller, rounded or obliquely-incised scales. These rows become fewer and fewer posteriorly till at last, at the end of the dorsal fin, only one remains. Below the lateral line there are 8 rows of high, posteriorly-incised scales and 4 rows of smaller, posteriorly-rounded ones, counted to the ventral margin of the body just in front of the anal fin. Thus from the beginning of the dorsal fin down to that of the anal we count 20 rows of scales in all, excluding the fin-covers. Most remarkable of all, however, are the latter, which on each side of the body rise along the dorsal edge and sink at the posterior ventral and the caudal margins of the body, like distinct walls surrounding the bases of the dorsal and anal fins and forming deep grooves in which each of these fins may freely rise and sink or even be hidden altogether. These covering scales (fin-covers), which are marked *a* in figure 21, are at first quite low at the beginning of the fin, then gradually increase in height up to the 20th scale, which with the next ten are the highest, then again diminish and end in one longer scale, more elongated in form, at the last ray in each fin. At first the interstices between the fin-covers are very narrow, and each of the scales is folded at the upper margin and overlaps the next one to it, but gradually these folds disappear, the margin becomes simple and thin and the groove proportionally wider.

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[a] This is true of the specimen belonging to the Royal Museum. In the specimen borrowed from Upsala Museum, which is also dried, the posterior nostrils, too, are round. This difference may perhaps depend on the difference in the manners of drying.

The dorsal fin begins in front of the insertion of the pectoral and the beginning of the anal, almost vertically above the posterior orbital margin or, as in the younger specimen, somewhat behind it. According to LILLJEBORG it consists of from 51 to 53 rays[a], the first 9 being short and spinous and most of the others unarticulated and simple, but the posterior ones articulated and branched, the last of all doubly. The longest rays seem to have been situated just behind the spinous ones and to have been at least $^2/_5$ of the greatest depth of the body in length; probably, however, these, too, ended in very fine points, united by an extremely thin, scaleless membrane. The anal fin is of the same form and structure as the dorsal, the number of pairs of fin-covers being about 40. Its longest ray, the 4th or 5th, measures about $^3/_4$ of the greatest depth of the body in the younger specimen. The pectoral fins are narrow, long and obliquely pointed: in both of the specimens examined they are broken off short, but their length has been at least $^3/_5$ of the greatest depth of the body. The ventral fins lie a little in front of the insertion of the pectoral. According to LILLJEBORG they are covered above and below by a few elongated scales. The caudal fin is deeply forked and thickly covered with thin scales, which form rows on the membrane like those which in the genus *Brama* occur on all the vertical fins.

Pterycombus brama is exceedingly rare and has been found in an adult state only on the west coast of Norway, from Finmark down to the most southern part in the neighbourhood of Egersund; and up to the present only 12 such finds have been recorded[b]. One specimen, caught in a salmon-net in Varanger Fjord in 4 feet of water, seems to prove that the species sometimes wanders into the shallower parts of the ocean; but it is really an inhabitant of the depths of the sea, from 100 fathoms to greater depths. The young specimen described by LÜTKEN (l. c.) was taken out of the stomach of an Albicore (*Orcynus germo*), slightly north of the Equator, between Africa and South America, in 8 ° N., 24 ° W., and thus shows that the species has a wide geographical range.

(FRIES, SMITT.)

GENUS BRAMA.

The dorsal fin begins behind the insertion of the pectoral, the anal at about the middle of the body (excluding the caudal fin). *The longest rays of these fins measure less than the greatest depth of the body. No fin-covers; but on the membrane of all the vertical fins a row of similar scales along the back of each ray. Eyes fairly large, the diameter, however, in full-grown specimens only about $^1/_4$ of the length of the head. Teeth both on the palatine bones and the vomer, though the latter often disappear in old specimens and even in young ones are sometimes wanting.*

This genus, too, is one of the rarities of the Scandinavian Fauna, though far from being as rare as the preceding one. It is also much better known, for, in the Mediterranean and the Atlantic outside it, it is still less rare, and, we may say, is observed as often as deep-sea fishes in general can be. It has also been met with not only in the Atlantic but also in the Pacific and Indian Oceans. The form of the body and the other characters essentially correspond in many respects to those of the preceding genus. The relation between the two genera may be systematically expressed, in NILSSON's words, "by the striking metamorphosis through which the oblong, linear scales, which in *Brama* cover the dorsal and anal fins, have sunk in *Pterycombus* to the base of these fins and there become united into large ‘fincovers’, though still maintaining their oblong, linear form.” In this idea of the progression of development (metamorphosis) between the two genera, we may also find the explanation of the other differences between them. In *Pterycombus* the dorsal and anal fins are longer and begin nearer the head, but this is also true of the adult specimens of *Brama* compared with the younger. In the former genus the superior profile of the body slopes uniformly in a slight curve from the beginning of the dorsal fin to the tip of the snout, and this is also true of the younger specimens of *Brama*, in which genus the height of the forehead and the abrupt slope of the snout become developed only later in life. The spines on the scales which we have seen in *Pterycombus*, are also represented in *Brama*, but are here really to be regarded as evanescent growths. In other respects the formation of the scales is essentially the same in both genera; but the widening of the *high* scales and their singular form, reminiscences of the Ganoid type, are more marked in *Pterycombus* and the younger specimens of *Brama*. Thus in the development of the dorsal and anal fins *Pterycombus* is more advanced than *Brama*, while in the other characters mentioned above *Pterycombus* has stopped short at a stage of development corresponding to the juvenile stage in *Brama*. As in Pterycombus, the ventral fins are also covered with scales in this genus, and in *Brama* there also appears a row of singular scaly growths, elongated into a spoon-shaped form, and situated in the axil on a dermal flap which extends along the inner base of the pectoral fin[a]. The gill-openings are also large in *Brama*, but the branchiostegal membranes are united under the isthmus from about the middle of the lower jaw.

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[a] The number of pairs of fin-covers in both the specimens mentioned above is 50 and each of them seems to belong to a separate ray.

[b] COLLETT, N. Mag. Naturv., Bd. 29 (1884), p. 59.

In the genus *Brama* 9 species have been distinguished among adult specimens, but the correctness of perhaps most of them is still doubtful. In his meritorious treatment of this question Lütken[b] has pointed out the character which may be derived from the different number of rays in the anal fin. When we also observe that the species, all West Indian, which are distinguished by the shortest anal fin, also have the hind margin of the caudal more or less curved in an S-shape, while in the other species it is simple but deeply forked, we have here a ground for the distinction of at least two groups of forms within the genus. This, however, does not preclude the possibility that even the number of rays and the length of the anal fin may also prove subject to such changes due to age that the character derived therefrom may lose its validity. However, as the same changes affect the dorsal fin as well, we naturally obtain a surer test of the character by comparing the two fins with each other. Even the number of rows of scales on the body may be employed, at any rate in extreme cases, as characters for the species. But here we are met by the difficulty of counting these rows with uniformity and excluding the more or less irregular layers of scales in front of the caudal fin and on its base. Lütken remarks that if, with Günther, we count along the lateral line, we find from 80 to 95 rows, but according to Lunel’s method of counting in a straight line from the upper end of the gill-opening, we find only from 70 to 76 rows in *Brama Raii*, the species in which Lilljeborg has counted from 70 to 80 rows. The statements which are not accompanied by a clear explanation of the manner of counting, thus lose a great part of their value, especially as age seems also to involve an increase in the number of rows of scales.

Among the forms of this genus two Scandinavian species have been distinguished, both with the base of the anal fin more than 70 % of that of the dorsal:

1: Base of the anal fin more than 40 % of the length of the body; greatest height of the dorsal about $^2/_3$ of the length of the head .... *Br. Raii.*

2: Base of the anal fin less than 40 % of the length of the body; greatest height of the dorsal almost equal to the length of the head .... *Br. longipinnis.*

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[a] For the morphological significance of this dermal flap see below on *Chirolophis galerita.*

[b] *Spolia Atl.*, l. c., p. 497.

RAY'S SEA-BREAM.

BRAMA RAII.

Plate VI, fig. 1.

Length of the lower jaw less than $^2/_5$ of the length of the anal fin, which is more than $^2/_5$ of the length of the body. Greatest height of the dorsal fin less than $^2/_5$ of its length or than $^3/_4$ of the length of the head.

R. br. 7; *D.* $\frac{3\ \text{l.}\ 4}{30-32}$; *A.* $\frac{2\ \text{l.}\ 3}{28-30}$; *P.* 2 + 17 l. 20; *V.* $^1/_5$; *C.* $x + 15 + x$[a].

Syn. Brama marina cauda forcipata, Ray, *Syn. Pisc.*, pag. 115.
Sparus Raii, Bl., *Ausl. Fisch.*, part. 5, p. 95, tab. 273; Id. (*Brama*), *Syst.* ed. Schneider, p. 99; Schagerström, Vet.-Akad. Handl. 1827, p. 207, tab. VII; Cuv., Val., *Hist. Nat. Poiss.*, vol. VII, p. 281, tab. 190; Nilss., *Prodr. Ichth. Scand.*, p. 71; Krøy., *Danm. Fiske*, vol. 1, p. 211; Nilss., *Skand. Fn., Fisk.*, p. 121; Gthr, *Brit. Mus. Cat., Fish.* vol. II, p. 408; Lunel, Mém. Soc. Phys. Hist. Nat. Genève, vol. XVIII, p. 170, *Rev. Castagn.*, tab. I; Steind., Stzber. Math. Naturw. Cl. Akad. Wiss. Wien, 57 (1868), I, p. 374; Coll., Vid. Selsk. Forh. Christ. 1874, Tillægsh., p. 46; ibid. 1879, p. 30; Malm, *Gbgs, Boh. Fn.*, p. 420; Winth., *Zool. Dan., Fiske*, p. 18, tab. IV, fig. 8; Id. Naturh. Tidskr. Kbhvn., ser. 3, vol. XII, p. 14; Lütk., *Spol. Atl.*, Vid. Selsk. Skr., Kbhvn, ser. 5, vol. XII, p. 491, tab. IV, fig. 1; Day, *Fish. G:t Brit., Irel.*, vol. 1, p. 114, tab. XLI; Lillj., *Sv., Norg. Fiskar*, part. I, p. 300; Jord. et Gilb., *Syn. N. Amer. Fish.*, Bull. U. S. Nat. Mus., No. 16, p. 915.
Brama chilensis, Gay et *Br. australis*, Val. (Cuv. *R. Anim. illustr.*, tab. 44, fig. 1): — vide Lunel, l. c., p. 179.
Brama japonica, Hilgend. — vide tamen Lütken, l. c., p. 494.

The form of the body is high, and in this, as in the other species of the genus, assumes with age almost equal curves of the dorsal and ventral profiles. In youth, however, the curve of the ventral profile is much the sharper, especially in front, and the eye is near the profile of the forehead, but in the adult state the forehead and occiput are elevated as in *Coryphæna*, so that the eye is apparently removed lower down, though it really retains its original position, its centre being about on a level with the tip of the snout.

Another character which may be employed, though none the less with caution, to distinguish Ray's Bream, is the straight base of the anal fin with a distinct angle in its break towards the anterior ventral profile. Caution is necessary as in youth the base is more curved, though less than that of the dorsal, and the curve of the ventral profile is then continued along the anterior part of the base of the anal fin. The peduncle of the caudal fin is narrow and its lateral compression much stronger in young specimens than in old, which in this respect approach nearer and nearer the Mackerel-type. The form of the body becomes on the whole lower[b] and thicker[c] with age. The height of the pointed anterior part of the dorsal and anal fins increases with age, up to a certain degree at least, while the remainder of the fin becomes comparatively lower. But, as the length of the fins increases with age still more rapidly, their height in proportion to their length diminishes as the fish grows older[d]. Increasing age has an exactly opposite effect on the pectoral and ventral fins: it lengthens the former and shortens the

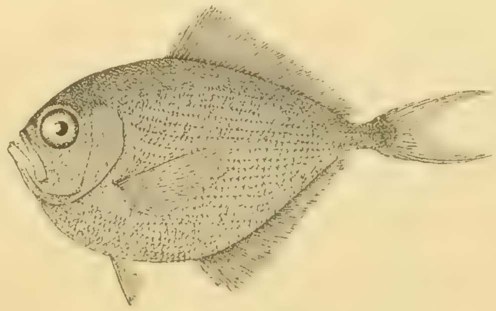

Fig. 23. Young specimen of Ray's Sea-Bream labelled "Brazilia" from the older collections in the Royal Museum. Natural size.

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[a] In a specimen from the Mediterranean we find *C.* $x. + 16 + x$.

[b] In a specimen 56 mm. in length the greatest depth = 48 % of the length, while in a specimen 472 mm. long it is only 41 %.

[c] In the smaller specimen just mentioned the greatest thickness of the head is 26 % of the greatest depth of the body, in the larger it has been presumably about 29 % (the specimen is stuffed), and according to Lilljeborg it may rise as high as 35 %. The statement of Cuvier, Lunel etc. that in adult specimens the thickness of the body may be as low as 25 % of the greatest depth, presumably refers to the thickness behind the head.

[d] In the smaller specimen mentioned above, the height of the dorsal fin is almost 36 % of its length, in the larger specimen only 30 %; and that a diminution in the height of the dorsal fin, even in proportion to that of the body, may occur after a certain age, seems proved by Lilljeborg's observation of a specimen 210 mm. in length from the Mediterranean with "the greatest height of the dorsal fin slightly less than $^1/_2$ of that of the body," while the height of the dorsal fin in the specimen 472 mm. in length which belongs to the Royal Museum, is only about $^2/_5$ of the greatest height of the body.

latter[a]. The long, pointed caudal lobes are the result of considerable changes due to age, but sometimes seem, according to Lütken's figure (l. c., tab. IV, fig. 1), to be formed at an early period[b]. The changes of age as well as individual peculiarities cause remarkable variations in the dental equipment of the mouth. A young specimen, 56 mm. long, has in the upper jaw an outer row of large teeth, and inside this in the back part one row and in front two irregular rows of smaller teeth; in the lower jaw there are two pairs of large canine teeth in front, belonging to the inner row, which throughout is made up of larger teeth than the outer; on each palatine bone is a row of small teeth, but the vomer is without teeth. Lunel has, however, remarked (l. c., pp. 171 and 172) the irregularity of the occurrence of the teeth on the vomer and the occasional shedding of the jaw-teeth, which leaves only the outer row in each jaw. The spines at the margin of the preoperculum still exist in specimens 56 mm. in length, where 12 of them may be counted, though they are indistinct.

The differences between the scales on different parts of the body are highly remarkable. The snout, the anterior part of the forehead, the intermaxillaries, and the margin of the hind lower corner of the preoperculum are the only scaleless parts of the body. In younger specimens the boundary of the scaly part of the head begins vertically above the posterior third of the eye and runs fairly straight down the sides, but in older specimens it begins above the anterior orbital margin and on the sides of the head runs obliquely downwards and backwards to the hind upper part of the orbital margin. Winther[c] has pointed out the resemblance to the *Sparidæ* in the pores which pierce the scaleless skin, and he also refers to the same system of sensory organs (the system of the lateral line) the pores in the scales which occur in this species as in *Pterycombus* (see fig. 20 above). The distribution of the different kinds of scales is also essentially the same as in the latter species; but in Ray's Bream the lateral line, which from the upper corner of the gill-opening roughly follows the curve of the back, forms, at least in the anterior part of the body, a well defined boundary between the smaller and more rounded scales of the back and the higher (broader) scales of the lower parts of the body. The former are in old specimens smooth and perfectly cycloid, but in younger specimens the radiating striations on these scales, as Lütken[d] remarks, are granular or even spinous and give the scales a ctenoid character. On the lower (broader) scales Lilljeborg[e] was the first to remark the spine in the middle of each scale, which disappears with age. In our smallest specimen (fig. 23) these spines are especially distinct on the lower parts of the ventral sides proper, and between the ventral fins and the vent they make the ventral edge dentated as in the Sprat. In older specimens, where the spines have disappeared, the scaly covering of the belly and the pectoral (shoulder-) region is remarkable for its closer resemblance to the scales of the back and head, and by this contrast to the covering of the other lateral parts reminds us in some way of the corslet of the true *Scombridæ*.

Owing to these differences between the scales of the body, we have above omitted, in the usual fin and scale formula, to give the number of scales in the lateral line. In our smallest specimen we find 61 transverse rows of dorsal scales and about 50 in a straight line below the lateral line; in an older specimen 90 transverse rows of dorsal scales, and above the lateral line, counting obliquely downwards from the beginning of the dorsal fin, 14 scales in one of these rows, below the lateral line 16, thus making in all 31 longitudinal rows of scales.

The colouring of the body is brownish with a silver or tin-white gloss; but the dorsal edge and the membrane of the vertical fins where it is free from scales at the margin, are blacker, the caudal fin, however, being edged with white at the hind margin. To judge by v. Wright's drawing of a fresh specimen the black colouring also extends over the snout and branches sideways along the depression above the eyes. The pectoral and ventral fins yellowish.

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[a] In the smaller specimen mentioned above, the length of the pectoral fins is almost 30 % of the length of the body and of the ventral almost 12 %: in the larger specimen these proportions are respectively 33 % and 8 %.

[b] In the smaller specimen mentioned above, the length of the middle caudal rays is about 42 % of that of the longest ones, and the fin is thus much less deeply forked than in Lütken's figure, the original of which, however, was younger or at least smaller, while in our larger specimen mentioned above, the length of the middle rays is only 18 % of that of the longest.

[c] *Zool. Dan.*, l. c.

[d] l. c., p. 495.

[e] *Om Pterycombus brama*. l. c.: — cf. also Lütken, l. c., pp. 495 and 496.

In the Mediterranean, according to Risso[a], Ray's Bream attains a length of 70 cm. and a weight of 6 kgrm. The specimen taken by Schagerström on the 25th of November, 1825, on Hildesborg shore near Landskrona "after a stormy night with a strong N. W. wind," was 607 mm. long (including the lobes of the caudal fin) and 2·87 kgrm. in weight. Four other specimens are recorded by Nilsson as taken on the west coast of Sweden from Scania to Bohuslän, and one of them, which was cast up after a N. W. storm on the 16th of December, 1843, in the neighbourhood of Tjörn[b], is now in the Royal Museum and was the original of v. Wright's drawing. Its length is 472 mm. to the end of the middle caudal rays. There is no record as yet of its capture in Norway; but in Denmark, according to Kroyer, it has been cast ashore after stormy weather three times in Zealand, and according to Winther[c] it has once (1876) been caught off the Skaw. In the Museum of Greifswald[d] there is said to be a specimen from the Baltic. However, it really belongs to the Mediterranean and the Atlantic outside it. It is said to have been found once off Newfoundland[e], and if our list of synonyms be correct, it has an equally wide range in the Pacific.

In the Mediterranean Ray's Sea-Bream ranks as a delicacy, but as it is really an inhabitant of the depths of the sea, up to 900 metres — "the large eyes and the high development of the dermal sensory organs," says Winther, "make it admirably suited for a life in the ocean-depths" — no constant method of fishing for it can be adopted. Only during summer does it come up in small bodies nearer the surface, probably in order to spawn, and it is then caught in fairly large numbers on long-lines at certain spots, near Genoa for example. The fishermen also say, according to Lunel[f], that it is most often taken at a depth of from 400 to 500 metres during the sinking or raising of the long-line. Thus it does not seem by any means to be a constant inhabitant of the bottom of the sea.

The specimens met with in Scandinavia have most often been found cast up on shore after storm, a fact to which Lütken[g] has called special attention. In order to explain why these specimens have come so near the surface and so far away from their true home in the depths that they could feel the effects of storm, the assumption has been made that they were troubled by parasitic worms — it is known that Ray's Bream suffers from them greatly, especially during summer — and that it was this disease that drove them away from their usual life and home.

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[a] *Eur. Mér.*, vol. III, p. 454.

[b] Ekström, Gbgs Vet. Vitt. Samh. Handl. 1850, p. 37.

[c] Naturh. Tidskr., l. c.

[d] Möbius and Heincke, *Fische der Ostsee*, p. 41.

[e] Brown-Goode: *The Fisheries and Fishery Industries of United States*. Sect. I (Wash. 1884), p. 335, where this species is also said to have been found in Bermuda.

[f] l. c., p. 177.

[g] l. c., p. 492.

RASCH'S SEA-BREAM.

BRAMA LONGIPINNIS.

Fig. 24.

Length of the lower jaw more than $^2/_5$ of that of the anal fin, which is less than $^2/_5$ of the length of the body. Greatest height of the dorsal fin more than $^2/_5$ of its length or than $^3/_4$ of the length of the head.

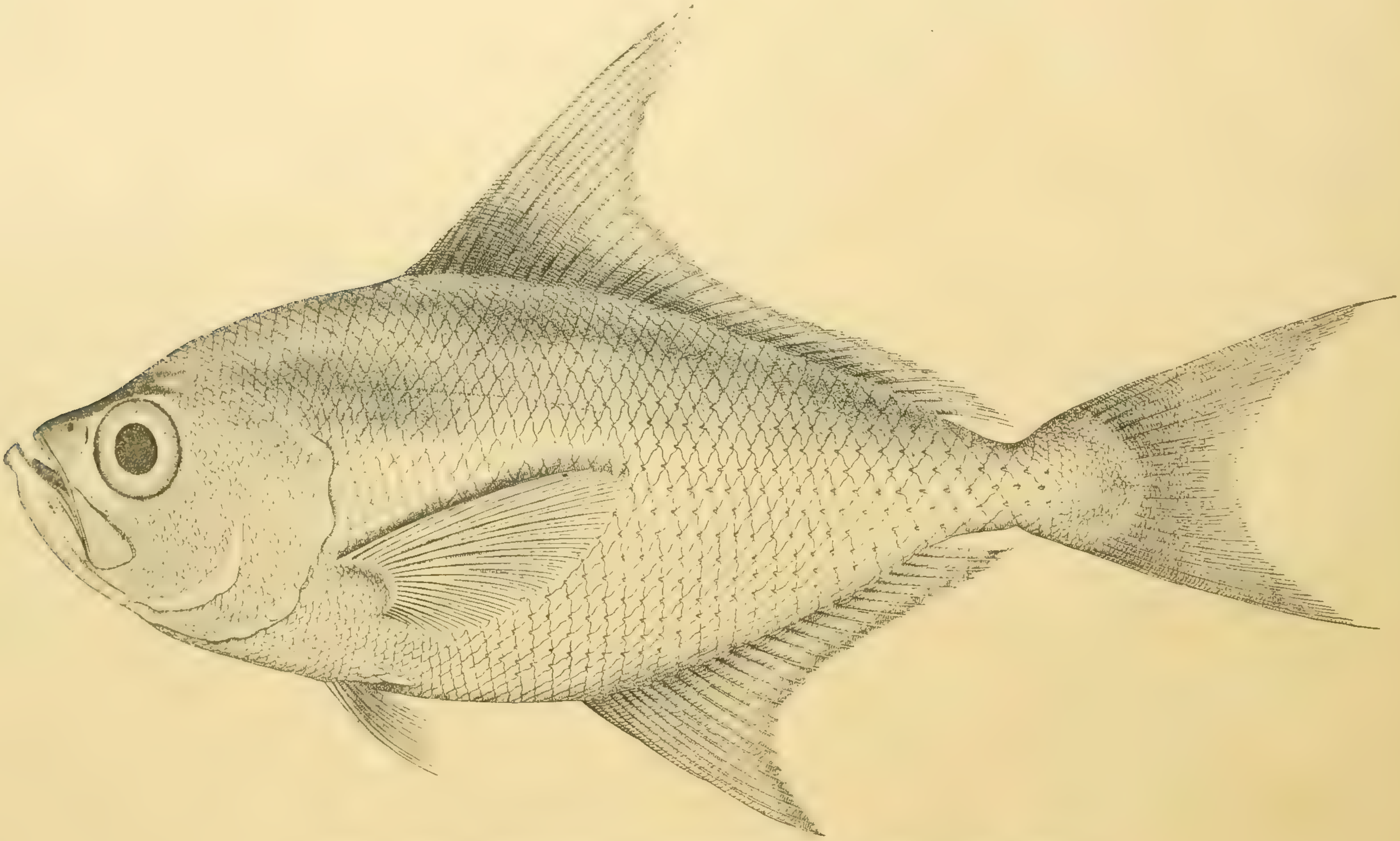

Fig. 24. *Brama longipinnis* from Hammerfest. $^1/_2$ nat. size. After ESMARK.

R. br. 7: *D.*[a] $\frac{4}{28}$: *A.*[b] $\frac{2}{22}$: *P.*[c] 18: *V.* $^1/_5$: *C.*[d] $x + 15 + x$(?).

Syn. *Brama longipinnis*, LOWE, Proc. Zool. Soc., Lond., 1843, p. 82; LILLJ. Ups. Univ. Festskr. 4 Nov. 1864, p. 7.

Brama Raschii, ESM., Forh. Vid. Selsk. Christ. 1861, p. 238 cum tab.; Forh. Skand. Naturf. Möde, Christ. 1868, p. 521; COLLIN, Forh. Skand. Naturf. Möde, Kbhvn. 1873, p. 418; COLLETT, Forh. Vid. Selsk. Christ. 1874, Tillægsh., p. 46; LILLJ., *Sv., Norg. Fiskar*, p. 310.

(?)*Brama princeps*, JOHNSON, Proc. Zool. Soc., Lond., 1863, p. 36.

(?)*Brama Raii*, LÜTK., *Spol. Atl.*, l. c., tab. IV, fig. 2.

Obs. In his first description of this species LILLJEBORG held that ESMARK'S *Brama Raschii*, now known both in Norway and Iceland, should be considered identical with LOWE'S *Brama longipinnis* from Madeira. The objections to this opinion given by ESMARK, COLLIN, and COLLETT only concern the changes due to age in the head and fins, which we have mentioned above and which certainly apply here, too. Only the more elongated (lower) form of the body might perhaps suggest a difference of species. But in a genus which in this respect is as variable as *Brama*, we can scarcely draw a difference of species from the higher or lower form of the body when the difference is so small and measured in only one single specimen. Nor can I find any other reason for distinguishing JOHNSON'S *Brama princeps* from this species than the fact that in the large specimens from Madeira (686—838 mm. long, excluding the lobes of the caudal fin) examined by JOHNSON, there was "a broad keel on each side of the middle portion of the tail". This discovery is especially important as it clearly refers these forms to the group of the Scombromorph families, but it does not therefore preclude the possibility of this being a character of age which has not yet appeared in the specimens described under the names of *Br. longipinnis* and *Br. Raschii*, the largest of which, LOWE'S specimen, is 463 mm. long. Thus in Scandinavia as well as in the Atlantic off Madeira, we should have to distinguish two species, which are called by the fishermen of Madeira "Freira" (*Br. Raii*) and "Freira do alto" (*Br. longipinnis*). From the changes due to age in the relative length of the dorsal and anal fins, which are given below, it seems quite possible that the young specimen figured by LOWE in fig. 2, plate IV of his much-quoted work belonged to this species, though to judge by the figure this circumstance, had it occurred in a more fullgrown specimen, would certainly have referred it to the West Indian branch of the genus.

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[a] *D.* $\frac{4}{31}$ according to LOWE; $\frac{5}{27\quad 33}$ in *Brama princeps* according to JOHNSON.

[b] *A.* 27 according to LÜTKEN; $\frac{2}{26}$ according to LOWE; $\frac{3}{26}$ in *Br. princeps* according to JOHNSON.

[c] *P.* 20 according to LOWE; also in *Br. princeps* according to JOHNSON.

[d] *C.* $4 + 17 + 4$ according to LOWE; $4 + 15 + 4$ in *Br. princeps* according to JOHNSON. ESMARK gives *C.* 20, whence I assume that he also counted all the visible supporting rays. As usual, in the above formula by x we denote the upper and lower, simple, supporting rays.

Rasch's Sea-Bream is evidently an intermediate form between *Brama Raii* and the West Indian branch of the genus, the latter being distinguished by the shortest anal fin, but, however, including a high-finned form (*Br. Brevorti*) as well as two comparatively low-finned (*Br. Agassizii* and *Br. Saussurii*)[a], between which we should have to distinguish if the distinction of species in this branch of the genus could be regarded as fixed. The relation between Rasch's and Ray's Sea-Breams is in most respects, however, a distinct expression of the different stages in one and the same course of development, in which the former represents the less advanced stages. This appears even in the more perfect retention of the spines on the scales, but also strikes us in several of the other changes due to age, which we have traced as far as the scanty materials at our disposition and the measurements given by other writers admit. It is with this object that we have drawn up the following table of comparison, assuming that *Brama princeps* represents one of the most highly developed stages of *Br. longipinnis*.

	Brama longipinnis		*Brama Raii*	
	ESMARK.	JOHNSON.	juv.	sen.
Length of the body to the end of the middle caudal rays ... mm.	334	(701—712)?	56.3	472
1) Length of the anal fin in % of that of the body ... %	31.8	<38	40.9	42.4
2) „ „ „ lower jaw „ „ „ „ „ „ anal fin ... „	53.1	—	34.8	29
3) Greatest height of the dorsal fin „ „ „ its length ... „	> 56	42.8	35.7	30
4) „ „ „ „ „ „ „ „ „ the length of the head ... „	> 90	92.3—100	64.3	71.8
5) Length of the anal fin „ „ „ „ „ „ „ dorsal ... „	72	75	91.2	80.3
6) „ „ „ head „ „ „ „ „ „ „ body ... „	27.9	<27	24.8	21.8
7) „ „ „ „ „ „ „ „ „ „ „ dorsal fin ... „	63.2	46.4	55.5	41.4
8) „ „ „ „ „ „ „ „ „ „ „ anal „ ... „	87.7	61.9	60.9	51.5
9) „ „ „ „ „ „ „ „ „ „ „ pectoral fins ... „	102.4	84.7	82.4	68.7
10) „ „ „ lower jaw „ „ „ „ „ „ „ body ... „	16.8	—	14.2	12.3
11) „ „ „ „ „ „ „ „ „ „ „ „ head ... „	60.5	—	57.1	56.3
12) „ „ „ „ „ „ „ „ „ „ „ „ dorsal fin ... „	38.2	—	31.3	23.3
13) Breadth of the interorbital space „ „ „ „ „ „ „ lower jaw ... „	57.7	—	51.2	48.5
14) Length „ „ dorsal fin „ „ „ „ „ „ „ body ... „	44.1	<51	44.7	52.7
15) „ „ „ pectoral fins „ „ „ „ „ „ „ „ ... „	27.3	>30 <32	30.2	33
16) „ „ „ ventral „ „ „ „ „ „ „ „ pectoral fins ... „	45.2	16.9	38.8	24.3
17) „ „ „ „ „ „ „ „ „ „ „ „ body ... „	12.3	<6	11.7	8
18) „ „ „ „ „ „ „ „ „ greatest height of the dorsal ... „	< 50	20.8—20	73.3	51.3

In all these proportions except Nos. 4, 5 and 18 we can easily see that where the changes of age in *Br. Raii* show an increasing ratio, in *Brama longipinnis* the percentage is least, and *vice versâ*. We must, however, pay attention to the age as well, provided it be expressed by the length of the body, for then the specimens described by JOHNSON must have passed through changes considerably greater than the oldest specimen of *Br. Raii*. It is from this cause, too, that, in the three exceptional relations (4, 5 and 18), we should really look for the ratio of ESMARK'S specimen nearest to, but still below or above that of the older specimen of *Br. Raii*.

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[a] With respect to these forms see LUNEL, l. c., pp. 182 etc., Plate II.

Besides the information we may thus gain from the table, we also find in *Br. longipinnis* certain relations which cannot be explained in accordance with development. These chiefly concern the height of the body, which in ESMARK's specimen is considerably less than in *Br. Raii.* The specimens of JOHNSON, however, level this difference, though they contradict the direction of development which seems to be indicated by a comparison between the two specimens of *Br. Raii,* just as the exceptional relations mentioned above. This want of accordance suggests a true distinction of species or a difference in the course of development[a], even though the differences expressed in the above table may be eliminated by a richer supply of materials for examination. The scales correspond in form, as we have mentioned, to those of the preceding species, but their number is considerably less, there being only from 41 to 45 in the lateral line according to the statements to which I have access. In the colouring there seems to be no real difference from the preceding species.

Rasch's Sea-Bream has been met with in the North on only two occasions, once when it was caught in Varge Fjord off Alten in Norwegian Finmark, and a second time when it was cast ashore on the Westman Islands, Iceland. The rarity of this fish naturally precludes all possibility of its possessing any special value for the fisherman.

FAM. CARANGIDÆ.

Form of the body elongated or high, perciform or strongly compressed. Eyes middle-sized or fairly large. Of the external bones of the head the preoperculum and sometimes the frontal bones dentated at the margin or furnished with spines during youth, but in adult specimens smooth. Scales small or middle-sized — sometimes absent — and with smooth margin, sometimes, though only in the lateral line, resembling high, spinous plates. Spinous-rayed part of the dorsal and anal fins (or the anterior dorsal and anal fins, where each of these fins is double) *shorter than the soft-rayed part, but in youth at least, well developed; at least two spinous rays before or at the beginning of the anal fin. Simple, pointed teeth in sparse rows or a card on the jaws and palate, during youth at least. The superior longitudinal ridges of the skull highly developed, the high supraorbital crest anteriorly prolonged on the surface of the frontal bones as well. Ventral fins thoracic, and though sometimes reduced by age in size as well as structure, generally composed of 1 spinous ray and 5 soft. Branchiostegal rays usually 7*[b]. *Branched rays in the caudal fin 15 at least. Total number of vertebræ generally 24 or 25, 10 of which are abdominal.*

From the Mackerel family as adopted by CUVIER GÜNTHER[c] removed the greater part into a separate family, *Carangidæ,* the family of the Horse-Mackerels, which he characterized by the number of the vertebræ, stating that in these fishes it is lower than in the true Mackerels and their nearest relatives[d]. GILL[e] has pointed out a safer character, drawn from the structure of the skull and most distinctly expressed, as far as we can see, by the different development of the longitudinal ridges on the occiput, the forehead and the temples. In the *Carangidæ* these ridges are comparatively high, especially the middle, supraoccipital ridge, which extends forward over the coalescent frontal bones, and reminds us of the preceding family. The other two ridges belong to the temporal region, whence they extend more or less forward on each side of the skull, the one starting from the mastoid (epiotic) bone and sometimes, as in *Trachynotus,* continued along the side of the frontal bones as far as the rostral region, where it meets the ridge of the opposite side, or, as in *Ca-*

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[a] So far as we can rely on the results attained by a study of the trifling materials which this species has hitherto afforded us.

[b] GILL, however, states that they vary between 5 and 10.

[c] *Cat. Brit. Mus., Fish.,* vol. II, pp. 354 and 417.

[d] GÜNTHER points out (l. c., p. 417) that the genera *Chorinemus* and *Temnodon* (*Pomatomus*) form exceptions: "but a comparison with *Lichia* shows that their natural position is by the side of this genus." That *Naucrates,* which GÜNTHER placed among the *Scombridæ* because of the number of its vertebrae, should really be referred to this family, has already been stated by GILL (Proc. Acad. Nat. Sc. Philad. 1862, p. 431). That the number of the vertebrae may be of less systematic importance than GÜNTHER here, as in other questions, e. g. in the *Salmonidæ,* ascribed to it, is also shown by HEINCKE's observations of the variations in this respect in the common Herring.

[e] Proc. U. S. Nat. Mus., vol. V (1882), pp. 487 etc.

ranx, apparently ending at the middle of the orbits or over their anterior part, but continued more or less distinctly by the marginal ridge of the frontal bones. The other, outer lateral ridge on the skull starts from the *os squamosum* (*pteroticum*) and is generally confined to the posterior frontal bone (*os sphenoticum*), but sometimes extends to the middle of the orbits. Though these ridges are not wanting in the true Mackerels, they are much less highly developed and do not extend so far forward[a]. This difference, however, like the number of the vertebræ, is an internal one and as a character is thus subject to practical difficulties in its employment for the determination of species belonging to this family. Furthermore, as it is rather a difference in the degree of development than in form[b], its validity as a family character may be doubtful, though we here retain the Carangoid family in order particularly to distinguish the Horse-Mackerels in our Fauna as a connecting link between the *Bramidæ* and the Mackerel group, a position clearly pointed out for them by the development of the above-mentioned, longitudinal ridges on the skull.

The correctness of this procedure is also shown by the developmental changes due to age, which are better known in the *Carangidæ* than in the *Scombridæ*. The most detailed information on this point[c] is given by LÜTKEN in his excellent work[d]. It is a universal rule that in the *Carangidæ*, as in the *Scombridæ*, the margin of the preoperculum is furnished with teeth or spines during youth, there generally being a few large spines at the corner and smaller spines or teeth on each side of them[e]. In the Pilot-fish (*Naucrates*) similar spines appear not only on the preoperculum but also on the posttemporal bone, the supraorbital margin of the frontal bones and even the rostral region[f]. These juvenile marks bear witness to the original analogy between this family and the *Beryx* type, as well as with the *Cottidæ*, though the *Carangidæ* are unquestionably brought nearer to the latter by the comparatively late appearance of the scales on the body, which in certain forms are completely wanting. The other changes due to age, as we have already seen in the Bramoids, consist in the elongation of the form of the body and of the pectoral fins — the latter becoming more and more pointed and directed more and more upwards with a more horizontal base — and also in the diminution of the ventral fins. We have also to notice in the *Carangidæ* the reduction of the first dorsal fin and of the spinous rays in the anal, the changes in the latter causing some likeness to the family of the true Mackerels. In some *Carangidæ* (*Selene vomer*), as a compensation for this reduction, the anterior parts of the second dorsal and the anal fins are developed into high, falciform flaps and the pectoral fins are simultaneously elongated. In others again (*Selene setipinnis*) age also causes a reduction in the length of the anterior parts of the dorsal and anal fins.

In a family with so great changes of development the definition of the genera and species has naturally been difficult and unfixed, for the different stages of development, before their correct signification was known, were regarded even as separate genera. However, even after the corrections made by later writers on this point, the Carangoid family still contains a large number of species. JORDAN and GILBERT[g] estimate the number as high as 180, the great majority of which belong to the tropic seas of both hemispheres. Many are highly esteemed as an article of food, and as they often occur in shoals, wandering at the surface out at sea or along the coast, they are of great importance to the fisherman. Their economical value, however, is far less than that of the true Mackerels. Only one species belongs to the Scandinavian Fauna.

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[a] The difference is given by GÜNTHER, though not as a family character, and may be found in his descriptions of the skeleton of *Scomber scombrus* (*Cat.*, l. c., p. 358) on the one hand, and *Caranx trachurus* (*Cat.*, l. c., p. 421), *Chorinemus lysan* (*Cat.*, l. c., p. 472) and *Lichia glauca* (*Cat.*, l. c., p. 478) on the other.

[b] This is also the case in the large species of Tunnies, where these ridges are, it is true, comparatively much lower than in the *Carangidæ*, but still high enough to cause it to be referred to as an exception when the supraocipital ridge in *Orcynus thynnus* (see CUV., VAL., *Hist. Nat. Poiss.*, VIII, p. 66) may be traced as far forward as the ethmoid bone.

[c] There are several remarks on the subject, however, in GILL: Proc. Acad. Nat. Sc. Philad. 1862, pp. 430 and 440.

[d] *Spolia Atlantica*, l. c., pp. 504—552.

[e] In an Indian species, *Caranx* (*Carangichthys*) *typus*, these teeth are retained even by adult specimens, provided that BLEEKER's description be really based on examination of fullgrown specimens; and in *Caranx lepturus* from the West Indies, they occur as uniform teeth at the corner of the preoperculum, though they are scarcely visible except on the skeleton. On the removal of the skin both the suboperculum and interoperculum also present distinct crenulations at the outer margin.

[f] That this genus, too, should be regarded as representing the earlier developmental stages of the family type, appears from its coloration, from the dark transverse bands, the number of which diminishes with age, while in *Caranx* these bands are generally present, it is true, but only as a juvenile character. *Caranx uraspis* (*Uraspis carangoides*), however, according to BLEEKER, retains these transverse bands even when fullgrown.

[g] *Syn. Fish. N. Amer.*, Bull. U. S. Nat. Mus., No. 16, p. 431.

GENUS CARANX.

The lateral line proper armoured, at least in part. The other scales on the body cycloid. Tail keeled on the sides. A spine starts, in a forward direction from the fourth interneural bone, which supports the first spinous ray in the anterior dorsal fin.

All the *Carangidæ* furnished with scales, which, like the Sticklebacks, have the lateral line wholly or in part covered with plates, — the form of which strongly reminds us of the high scales we have seen in the Bramoids — are so closely related to each other that with Günther we may well unite them into one single genus. The variety of form — about 80 species are more or less known — may induce us, it is true, to search for subdivisions within this genus. Such divisions have been proposed, grounded partly on the different extent of the armour on the lateral line, partly on the breaking-up of the posterior parts of the dorsal and anal fins into small, separate fins which occurs in some species. Both these differences, however, are met with as changes due to age in forms so closely allied in other respects that the assumption of a generic distinction appears unnatural. Lütken[a], too, though he still adopted the genus *Trachurus* as distinct from *Caranx,* writes as follows: — "At a certain age (at a length of 17 mm.) only the posterior half of the lateral line is distinct, and one might more readily suppose the young specimen before him to belong to *Caranx* than to *Trachurus.*" True, the same remark applies to the covering of scales, which is absent in the fry; but in addition to this lack of scales we find in *Gallichthys* so striking a development in the high form of the body and so great a reduction of the first dorsal fin that we may well follow Lütken and designate these forms by a special generic name, pointing to their importance as intermediate forms between *Caranx* and *Selene.*

In *Caranx* the system of the lateral line shows so high a degree of development as to place it on a level with or even above this system in *Cantharus.* From the arcuate canal in the posttemporal region (above the gill-cover and the upper corner of the gill-opening) which is continued without interruption by the lateral line proper, anteriorly there start two branches. The one as usual follows the outer edge of the preoperculum downwards and sends out its numerous lateral branches with small pores in the 'adipose membrane' which covers the broad margin of the preoperculum, and is continued on the lower side of the lower jaw. The other branch of the temporal canal advances towards the posterior orbital margin but divides into two, the one being continued forward above the eye to its middle point, the other belonging to the suborbital ring and, together with its many small branches in a downward direction, covered by the 'adipose membrane'[b] which lies over the posterior and anterior portions of the eye. These small branches and pores are, as usual, most distinct on the preorbital bone. From the temporal canal there also starts the ordinary upward branch towards the occiput, but in this case the most important continuation of the latter is the dorsal canal (the dorsal lateral line), which runs along the base of the dorsal fins, often right to the end of the posterior one. From the bow which forms the connection between this dorsal canal and the temporal one, there starts backwards, from the concave side of the bow, a smaller canal between the dorsal one and the lateral line proper, but nearer the former; and forwards, from the convex side of the bow, run the ordinary canal from the mastoid region, continued on the side of the forehead to the nasal region, and also another, smaller canal in the supraoccipital region as far as the interorbital space, where it meets the corresponding canal of the opposite side and united with this is continued along the middle of the forehead as far as the anterior orbital margin. In *Caranx trachurus* all these divisions of the system of the lateral line have transverse branches at right angles to them, which in their turn send out transverse branches on each side. But in the lateral line proper the transverse branches of the first magnitude (a pair for each plate, one upwards and one downwards) send out only backwards a number (from 5 to 7) of secondary branches[a], which open into the posterior margin of the plate. In older specimens of this species, in which these canals often become indistinct, we may still find numerous, scattered pores, especially on the back and head, which are the orifices of the system of the lateral line. Of the other species of the genus, *Caranx torvus* has the dorsal canal similarly continued almost to the end of the second dorsal fin, but in *Car. armatus* we have not been able to trace it farther than the beginning of the first dorsal, and in some specimens of *Car. lepturus* it may be traced to the end of the second dorsal, in others only to the beginning of the first, as is also the case in the genus *Selene.* The variations in this respect indicate the transition to *Temnodon* and the true Mackerels, some of which have only a rudimentary dorsal canal, while others are without it altogether.

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[a] *Spol. Atl.*, l. c., p. 536, on *Trachurus Cuvieri.*

[b] This membrane, it is well known, does not contain fat, but is a hyaline (gelatinous) connective tissue ("*Gallertgewebe*", Leydig) the presence of which round the muciferous canals of fishes has already been remarked by Leydig (*Lehrbuch der Histologie*, p. 24).

In *Caranx*, as in *Selene*, *Trachynotus* and *Lichia* (I am unable to speak with certainty of the other *Carangidæ*), the first three interneural bones are separate from each other, while the others are more or less closely united by the osseous ridges on their back and front. The coalescence is most complete between the 4th and 5th. From the 4th grows out in a forward direction the spine mentioned in the diagnosis, and the first spinous ray in the anterior dorsal fin is supported by the same bone. On each of the first three interneural bones there is a process in a forward direction which corresponds to the spine just mentioned. These processes do not, however, project above the skin, though the tops of these three bones are sometimes visible as oblong knobs in the edge of the back in front of the first dorsal fin.

The genus *Caranx* has gained some further interest in an anatomical respect from an observation the universal signification of which within the genus is, however, still unknown. The chief function of the air-bladder is, as is well known, to enable the body of the fish to maintain or attain the same specific gravity as that of the surrounding water. Thus, it is more compressed (the size of the fish smaller), but contains more gas (of greater density) in deep water than near the surface. When the fish gradually rises or sinks in the water or only slightly changes its position, the quantity of gas in the air-bladder is altered in proportion. When the fish is rising and it is necessary to diminish the quantity of gas, the Physostomi, whose air-bladder is furnished with a pneumatic duct, thus enjoy a great advantage, for those fishes which have no pneumatic duct, can only gradually diminish the quantity of gas by absorption. Hence, too, the great difference in the effect upon different fishes of a change in the pressure upon the water, e. g., when the pressure is diminished. Those which have no air-bladder, seem but very slightly affected by the change; those which have an air-bladder with pneumatic duct, emit gaseous bubbles through the mouth and gill-openings, but those which have an air-bladder without pneumatic duct, are drawn upwards in spite of their struggles to sink deeper and deeper, until, if they find it impossible to descend, they are quickly borne to the surface, where they lie swollen up and unable to move. In his endeavours fully to investigate this point ARMAND MOREAU[b] found that *Caranx trachurus*, far from being borne to the surface like the Basse and the other Physoclysts experimented on, when the air above the vessel in which it was placed, was rarefied, seemed only slightly uneasy and emitted only small gaseous bubbles. On closer examination he found in the upper wall of the air-bladder, in a line with the seventh rib, an opening surrounded by a raised, valvular margin and leading to a tube which follows the right side of the aorta in a forward direction and after a geniculate curve opens into the right gill-cavity.

Another peculiarity, the universal signification of which is still to be decided, is the fact that the fry of *Caranx trachurus* is a parasite of the Medusæ, a circumstance which is one of the many discoveries made by the late Professor A. W. MALM (see below).

The numerous species of this genus are excellent swimmers and thus, for the most part, have a wide range. They are therefore subject, as is usual under such circumstances, to fairly many variations of form.

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[a] They may be seen in McCOY's figure (*Prod. Zool. Vict.*, pl. XVIII), as it is reproduced in *Fish. a. Fisher. N. S. Wales* by TENISON-WOODS (Sydney 1882) pl. XXII, fig. 1 *a*, showing the inside of a plate from the Australian *Car. trachurus*, which figure may be compared with our figure of the high scales in *Pterycombus brama.*

[b] Ann. Sc. Nat., ser. VI, Zool., Tome IV (1876), Art. No. 8.

THE SCAD OR HORSE-MACKEREL (SW. TAGGMAKRILEN).

CARANX TRACHURUS.

Plate V, fig. 3.

The lateral line proper covered along its whole length with transverse plates, which, on the posterior part of the line, which is straight and longer than the anterior part, which is curved, are keeled and posteriorly furnished with a spine. Length of the head about 27 % of the length of the body and greater than the greatest depth of the body, which is about 22 % of its length. No finlets behind the dorsal or anal fin.

R. br. 7; *D.* 8 $\frac{1}{29-32}$[a]; *A.* 2 $\frac{1}{27-29}$[b]; *P.* 2 + 17 l. 18; *V.* $\frac{1}{5}$; *C.* x + 16 l. 17 + x; *L. lat.* 73—75[c].

Syn. *Σαύρος*, ARISTOT.; *Τραχούρος*, ÆLIAN.: vide ARTEDI.

Scomber linea laterali aculeata, pinna ani ossiculorum 30, ART., *Gen.*, p. 31; *Syn.*, p. 50.

Scomber Trachurus, LIN., *Syst. Nat.*, ed. X, tom. I, p. 298; RETZ., *Fn. Suec. Lin.*, p. 340; LACÉP. (*Caranx*) *Hist. Nat. Poiss.*, vol. III, p. 57 et 60; CUV., VAL., (*Trachurus*) *Hist. Nat. Poiss.*, vol. IX, p. 11, tab. 246; KROY. (*Caranx*) *Danm. Fiske*, I, p. 263; EKSTR., Gbgs Vet., Vitt. Samh. Handl. 1850, p. 37; ID. (cum WRIGHT) *Skand. Fiskar*, ed. I, p. 221, tab. 57; MALM, Öfvers. Vet.-Akad. Förh. 1852, p. 226; NILSS., *Skand. Fn.*, *Fisk.*, p. 152; GTHR (*Trachurus*) Cat. Brit. Mus., Fish., vol. II, p. 419; STEIND. (*Caranx*) Stzber. Akad. Wiss. Wien., Math. Naturw. Cl., Bd. LVII, Abth. 1 (1868) p. 382; COLL., Vid. Selsk. Forh. Christ. 1874, Tillægsh., p. 50; ID. ibid. 1879, p. 32; CEDERSTR., Öfvers. Vet.-Akad. Förh. 1876, N:r 4, p. 64; WINTH. Naturh. Tidskr. Kbhvn., ser. III, vol. XII, p. 15; ID., *Zool. Dan.*, *Fiske*, p. 19, tab. IV, fig. 1; DAY, *Fish.*, *G:t Brit.*, *Irel.*, I, p. 124, tab. XLIV; LILLJ., *Sv.*, *Norg. Fisk.*, I, p. 330; MÖB. u. HEINCKE, *Fische der Ost-See*, p. 37.

Trachurus saurus, RAFIN., *Caratteri di Alcuni Nuovi Generi* (1810) p. 20; JORD., GILB., *Syn. Fish. N. Amer.* Bull. U. S. Nat. Mus., N:r 16, p. 912; BROWN-GOODE, *Fisher. Industr. U. S.*, part. I, p. 326, tab. 103.

Caranx semispinosus, NILSS., *Prodr. Ichth. Scand.*, p. 84.

Trachurus Linnei, MALM, *Gbgs*, *Boh. Fn.*, p. 421; LÜTK., *Spol. Atl.*, Vid. Selsk. Skr. Kbhvn. ser. V, Naturv. Mathem. Afd., XII (6), p. 533.

The usual size of the Scad in the Cattegat is from 27 to 30 cm. The largest EKSTRÖM ever saw measured 395 mm. from the tip of the snout to the end of the middle rays of the caudal fin. The body is fusiform, an intermediate form between that of the common Mackerel and the Perch, somewhat compressed and so deep that the greatest depth, which is half way along the first dorsal fin, is about 22 % or 23 % of the length of the body. The greatest thickness, measured at the same point, is about half the greatest depth. The back is broad and rounded up to about the middle of the second dorsal fin, as is also the front part of the belly. On the belly from the insertion of the ventral fins to the vent, there is a groove into which the ventral fins may sink, and behind that another which contains the vent together with the two spines before the anal fin and the anterior part of that fin. A similar groove, in which the first dorsal fin and the anterior part of the second may be hidden, runs along the back. The head is of average size, cuneiform and so strongly compressed underneath that the branches of the lower jaw and the two interopercula touch below the isthmus. The length of the head is from 26·5 % to 27·5 % of the length of the body. The forehead is rounded with a narrow, filiform carina (the outward sign of the supra-occipital ridge) in the middle. It slopes towards the snout in a curve continued by that of the back. The snout is blunt and the mouth of average size. The lower jaw is the longer; its articulation, which forms an obtuse angle, is situated somewhat behind the anterior margin of the eye, and its length is equal to the distance between the tip of the snout and the posterior margin of the pupil. Fine teeth, which are scarcely distinguishable, are set in both jaws, on the tongue, on the wide head and the shaft of the vomer and on the palatine bones. The eyes are large and set high. Their vertical diameter is from 24 % to 22 % of the length of the head. The nostrils are nearer the eyes than the snout. Of the bones of the gill-cover the preoperculum is the largest: its margin is smooth and rounded at the corner. The operculum is small and triangular, with a crescent-shaped incision in the posterior margin, which is filled by a membrane, on which we find the large black spot so common in this genus. The gill-openings are large. The branchiostegal membranes are free, but that on one side of the body is united below the isthmus to that on the other side. There are 7 curved, branchiostegal rays on each side of the body. The body is covered with small, thin, oval scales of different sizes, and only the fins, the caudal fin excepted, the snout and the lower jaw are naked. The smaller scales of the body grow even between the plates of the lateral line, especially in the front part. The lateral line begins at the upper margin of the gill-opening, then runs in an almost imperceptible upward curve to a point vertically above the vent, where it forms a downward curve, and is then continued in a straight line to the base of the caudal fin. It is completely covered by about 75 transverse plates. Of these plates the anterior ones, from the beginning of the line to its curve at the end of the pectoral fins, are smooth; but from this point they are furnished with a high, sharp keel, which ends behind in a strong spine. The height of the keel gradually increases and hence the tail is twice as broad as high at the end of the dorsal fin. The number of spinous plates is from 35 to 38. These keels may be traced even in the skeleton by the hook on each side of the last caudal vertebra. The vent is about half-way between the tip of the snout and the middle of the base of the caudal fin, or a little in front of (sometimes at) the middle of the body[a].

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[a] Exceptionally 33—35, according to STEINDACHNER.
[b] „ 25—32, „ „ „
[c] „ 70—79, „ „ „

The anterior dorsal fin begins with a spine pointing forward and often covered by the skin, vertically above the insertion of the ventral fins, and ends above the vent. It is short and high, with 8 unarticulated, but weak, rays. The posterior dorsal fin is long, ends above the end of the anal fin and generally contains from 30 to 33 rays. The first of these is unarticulated and half as long as the second, which, like all the others, is branched and articulated. The pectoral fins are narrow, falciform and equal in length to the head. They each contain 19 or 20 rays, the two uppermost undivided and the top one of all unarticulated, the others branched oftener and oftener to the lower side of the fin. The ventral fins are long and pointed, extending almost to the vent. In form the anal fin is like the second dorsal. It generally contains 28 or 29 rays, the first of which is unarticulated. In front of this fin is another smaller one, with only two, small, spinous rays, which are joined by a membrane. The caudal fin is crescent-shaped, with 18 or 19 long rays, the two outer ones being undivided; there are also 4 or 5 smaller (rudimentary) rays at the top and bottom of the base.

The colour of the back is dark olive-green with lighter, wavy, transverse bands. The head and the sides below the lateral line silver with a dash of orange, like mother-of-pearl. The iris silver-white, the pupil dark blue. The interior of the mouth black like the inner side of the branchiostegal membrane, which is edged with silver. A large black spot at the upper margin of the gill-opening. The anterior dorsal fin transparent, the posterior dark gray, as is also the caudal: the other fins white.

The interior of the abdominal cavity is dark in colour, the liver pale red, large and bilobate, and the spleen large and triangular. The kidneys are black and of average size. The intestinal canal bends twice. The stomach is large and there are a large number of pyloric appendages (from 12 to 20, according to Günther). The ovaries are large, but the eggs small.

The food of the Scad consists of small fry and crustaceans. The most usual contents of the stomach are young Herrings, Sprats, or Sand-launces. It occurs in the Cattegat all along the coast of Bohuslän and is by no means rare, but is always taken singly. Ekström never found it in shoals, as it lives in other places, and could never hear of its being so found. According to Nilsson, it has, in addition to the name given here, those of *taggsill* and, off Kullen, *staggsill* and *staksill*[b]. Malm says that in Bohuslän it is called *piggmakrel* (Picked Mackerel) and *skrej*, while Cederström also gives the name of *silfverfisk* (Silverfish).

The Scads which are caught by whiffing (Sw. *ränndörj* = running-line) during the Mackerel-fishery in Bohuslän, at the beginning of June, have ripe roe in the ovaries. It may therefore be assumed that the spawning-season occurs in this month, though no place is known where this fish spawns. Most probably it does so out at sea. That it really does spawn in the Cattegat, is proved by the occurrence there of the fry, in company with the large jelly-fish (*Cyanea capillata*) so common there, of which it seems to be a sort of parasite[c]. The fry stay under the body of the jelly-fish, among its ovaries, and seem to feed exclusively on its eggs. This most remarkable habit was first observed by

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[a] In Todd's figure (Brown-Goode, l. c.) the vent is situated considerably in front of the middle of the body.

[b] All three names are about equivalent to 'Spiny-Herring'. Tr.

[c] Malm (l. c.) also found the fry in *Rhizostoma Aldrovandi*.

A. W. Malm, who described it in the report of the Royal Swedish Academy of Science for the year 1852. Mr. I. W. Grill has subsequently described, in letters to Ekström, some minute observations on this point, which were made in Heligoland.

Fry have thus been found of very small size. From the 22nd of July to the 18th of August[a], Malm found specimens from slightly over 12 mm. up to 36 mm. in length, and Mr. Grill says that on the 25th of September he found 23 fry about 35 mm. in length under a jelly-fish about 16 cm. in diameter. Generally only few, from 3 to 7, are found under the same jelly-fish. If removed from the jelly-fish and thrown into the water near it, they at once endeavour to regain their hiding-place, and at the approach of danger they creep close to the disk of the jelly-fish among its threadlike organs. Like all very small fry, they are at first quite unlike the adult fish, being short, with a high head of peculiar shape and with the mouth turned upwards. Until they are about 20 mm. long, the greatest depth of the body exceeds the length of the head; but when they are no more than 70 mm. long — at this age they have left the jelly-fish — they have become normal in this respect, the greatest depth of the body being from about 84 to 82 % of the length of the head. The plates of the lateral line first appear, though indistinctly, in specimens from 15 to 20 mm. long; afterwards they become more distinct and the lateral carinæ appear. In young specimens 35 mm. in length these parts of the body have quite the same form as in the fullgrown fish. Shortly after the fry have attained this size, in September (or later?), they apparently leave the jelly-fish and live independently, in company with young Herrings and Sprats. Scads of this kind from 75 to 100 mm. in length, are fairly common late in autumn, when they are taken with other fish in the seine.

During summer the Scad is lean, but in autumn, when it comes near shore, it is fairly fat and the flesh is but little inferior to that of the Mackerel either in quantity or in quality.

No special method of fishing for the Scad is practised in Sweden: it is only occasionally taken in seines drawn for other fishes. This is also the case in the west of the Baltic, where the Scad occurs, but probably goes no further east than the coast of Mecklenburgh. In the Baltic, too, it is generally taken singly, though, according to Möbius and Heincke, it is sometimes, in autumn, met with in shoals. Thus in November, 1872, about 32,000 Scads were taken in the Bay of Eckernförde. A similar occurrence has happened in Norway, too, where, according to Collett's assumption, the Scad goes at least as far north as Trondhjem Fjord. It appeared there in large shoals in the summer of 1862 and came up the fjords between Stavanger and Bergen. It sometimes appears in still larger shoals on the English coast. Off Glamorganshire, on the 29th of July, 1834, in the evening, the whole sea was so full of Scad that the surface seemed in a state of fermentation; and these enormous shoals continued to pass up the Bristol Channel for a week[b]. In mid-ocean, too, it collects in shoals at the surface, but generally near some reef[c], as on the Josephine Bank, between Portugal and the Azores, where at midsummer the Swedish expedition of 1869 fell in with numerous shoals of Scad, on which the gulls feasted greedily.

In the Mediterranean and the Atlantic outside it two varieties have been distinguished from the northern Scad[d], which, however, occurs there also. Thus Malm gave the northern form the name of *Trachurus Linnei* and characterized it as having at most 79 comparatively high plates on the lateral line. According to Lütken, the one of the Mediterranean forms, *Trachurus mediterraneus*, is distinguished by from 79 to 92 (according to Steindachner, from 79 to 86) similar, but lower plates. In the other, *Trachurus Cuvieri*, in contradistinction to the two forms just given, the straight, posterior part of the lateral line is said to be shorter than the anterior part or at most equal to it, while there are from 93 to 108 plates of average height on the lateral line, and the ventral fins are exceptionally short in comparison with the pectoral — in old specimens scarcely more than ${}^{1}/_{3}$ of the latter in length. These differences evidently run side by side with well-known changes due to age. The height of the lateral plates as well as their number also varies in individual cases. Thus the development of form in accordance with the changes due to age, has become most advanced, both in the Atlantic and in the Pacific, in the warmer parts of the ocean, where this species without doubt has its original home.

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[a] Cf. *Gbgs. Boh. Fn.*, p. 452.

[b] Yarrell, *Brit. Fish.*, ed. 1, vol. I, p. 155 and Day, l. c., p. 125.

[c] See the Magazine *Framtiden*, 1870, p. 348, note.

[d] Cf. Lutken, l. c.

[e] *Caranx Cuvieri*, Lowe, Trans. Zool. Soc. Lond., vol. II, (1873) p. 183, according to him = *Seriola picturata*, Bowdich, *Excurs. Madeira* (1825) p. 123, fig. 27.

Fam. SCOMBRIDÆ.

Body fusiform, more or less elongated. Head underneath (towards the lower jaw and the isthmus) so compressed that as a whole it more or less closely resembles a three-sided pyramid. Eyes middle-sized or small. Of the external bones of the head the preopercula during youth are dentated at the margin or furnished with spines, in adult specimens smooth (like the other bones). Scales small or completely wanting, but in the region of the pectoral fins most often large and forming a 'corslet.' Spinous part of the whole dorsal fin-system shorter than the soft-rayed; but there being two dorsal fins, the anterior (spinous) is longer than the continuous part of the posterior, when the latter, as well as the anal, has a number of finlets behind it[a]. *No free spinous ray, or only one, in front of the anal fin. Simple, pointed, conical or compressed (cutting) teeth, at least in youth, on the jaws and generally on the palate as well. Jaws of equal length, or the lower somewhat longer than the upper. Upper longitudinal ridges of the skull comparatively little developed: supra-occipital ridge not continued (at least not without a break) on the frontal bones. Ventral fins thoracic, generally with one spinous ray and five soft. Gill-openings large, and branchiostegal membranes separate. Branchiostegal rays 7. Branched rays in the caudal fin at least 15*[b]. *Vertebræ more than 25*[c], *more than 10 of which are abdominal.*

It is the Mackerel family, next to those of the Herring, Cod and Salmon, that is the most important to man from an economical point of view. Their sociable life makes these fishes comparatively easy to catch, and their good flavour and fatness give them a place of honour in the kitchen. This is also true, though in a less degree, of the preceding family, which the Scombroids, as we have already said, resemble so closely that the family-character is restricted to a higher or lower degree of development of certain peculiarities. In the Mackerel family, however, we never find the body so high and compressed as it sometimes is in the *Carangidæ*. Further, in the former family, the eyes are not so large as in some species of the latter, the bony ridges on the skull are not so high or so long, nor is the reduction of the ventral fins or of the first dorsal so great. But the spinous rays of the anal fin to a great extent vanish, and in the fusiform body, which is more or less elongated, we may sometimes find the number of vertebræ to be as high as 45.

The system of the lateral line is much less developed, externally at least, than in certain of the *Carangidæ*. The distinct dorsal canal is either entirely wanting or, as in *Scomberomorus* (*Cybium*), only extends as far as the beginning of the first dorsal fin[d].

In the Scombroids the articulation of the mouth is peculiarly arranged. On the outside of the lower jaw is a well-defined groove, which really corresponds to the fold beneath the underlip when it is laid down, in other fishes. This groove is continued in a downward direction back from the corners of the mouth. There is a corresponding groove in the upper jaw; but this is formed under the inferior margin of the preorbital bone. Both grooves serve to receive the upper jaw when the mouth is closed. For this purpose in the Tunnies there is an expansion of the furrow in the lower jaw at the corner of the mouth, where the broad posterior part of the upper jaw may rest. This expansion is fairly great even in *Auxis*. In the true Mackerels the upper jaw-bone slides completely under the preorbital bone, when the mouth is closed, and thus the expansion of the groove in the lower jaw is inconsiderable.

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[a] In the genus *Elacate*, which, it appears to me, should hardly be separated from the Scombroid family — GILL, however (*Cat. Fish. East. Coast N. Amer.*, 1873, Smiths. Misc. Coll., No. 283, p. 29), has made it a distinct family, after having previously (Proc. Acad. Nat. Sc. Philad. 1862, p. 126) referred it to the *Carangidæ* — the whole of the soft-rayed part of the second dorsal fin (as well as of the anal) is continuous, and in this case the spinous-rayed part of the dorsal — here broken up into free spines — is shorter than the soft-rayed. This is also the case in some species of *Echeneis*, which genus may still lay claim to a place among the *Scombridæ*, though the family-diagnosis can scarcely notice all such variations.

[b] According to LILLJEBORG, *Auxis thazard* has only 14 of these rays.

[c] According to GÜNTHER, there are only 25 vertebræ in *Elacate*.

[d] On the other hand a ventral branch of the lateral line occurs in *Orcynus* (*Thynnus*) *bilineatus*, a Tunny from the Red Sea which has been described by RÜPPELL.

Of the air-bladder there is nothing to remark, save that it is sometimes wanting in species very closely related to others where it is present. This family, however, like the following, is remarkable for the power which some of its larger members possess, of raising their own temperature considerably above that of the surrounding water. DAVY states[a] that on his voyage to Ceylon he found the temperature of body in a Bonito — "in the deep-seated muscles in the thickest part of the fish, a little below the gills" — to be 99° Fahr., while the temperature of the water at the surface was only 80.5°. He was also informed by fishermen that they had observed the same circumstance in the Tunny and in other large species of this family[b]. This increase of temperature is connected with the great muscular activity enjoyed by the Scombroids. This muscular activity has its physiological conditions in an abundance of richly corpuscular blood, a powerful[c] respiration and circulation, a thick, muscular heart and a strong innervation not only of the muscles of the body, but also of the organs of respiration. Thus DAVY found the basal ganglia of the gills (*ganglion branchiale*, belonging to *nervus vagus*) to be larger in the Scombroids than in other fishes and almost as large as the "electric ganglia" in the Torpedo. The quick and ready movements of these fishes are also aided by the reduction of the scales of the body which generally occurs in this family. The scales are sometimes fairly large, as in the region of the pectoral fins, and cycloid or — as in *Scomber kanagurta* from the Red Sea and the Indian Ocean — with wavy striations and crenulated at the margin. Often, however, they are wanting, at least externally, either over the whole body or over the greater part of its posterior portion, or else they are imbedded in the skin, as on the cheeks, where, as well as in the corslet, they are generally larger than on the rest of the body. All the Scombroids belong to the most active of salt-water fishes, and their power of wandering so far is closely connected with their wide geographical range.

About 70 species, all belonging to the seas of the Tropic and Temperate Zones, are recognised and described in GÜNTHER'S *Catalogue;* but several of these species are only imperfectly known, and on closer observation, as LÜTKEN has shown with regard to the Tunnies, will probably be explained as alterations due to age or varieties of other species. The number of forms within the family is large enough, however, to admit of sharp disputes not only in the distinction of the species, but also in their arrangement in genera. Though this may depend to a great extent on our ignorance of changes due to age in the different species, an additional reason is the considerable size of some of the species, which renders it difficult clearly to understand the relations of form. All that we know of the changes due to age, is summed up by LÜTKEN[d] in some observations on the spines of the preoperculum, the larger jaw-teeth, and the shorter maxillaries of the fry (in *Scomber colias*). He also describes some small fishes from 8 to 17 mm. in length, which he refers with good reason to some species of Tunny, and assumes this to be *Orcynus germo*. These small fishes (fig. 25) are short and compressed in form, with sharply dentated preoperculum and with the second dorsal and the anal fins continuous, but with signs of the breaking-up of the posterior part into finlets. The mouth is large, its aperture, when shut, rising at an angle of 45°. The pectoral fins are broad and short, and the ventral short and rounded. With regard to the continuation of the changes of form during growth,

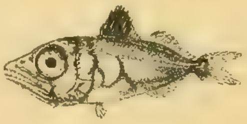

Fig. 25. Young Tunny, probably *Orcynus germo*. 3 times the natural size. After LÜTKEN.

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[a] Edinb. N. Phil. Journ., vol. XIX (1835), p. 325.

[b] Cf. also CARPENTER: *Man. Physiol.*, p. 481; COUCH: *Fish. Brit. Isl.*, vol. II, p. 95; McCOY: *Prodr. Zool. Vict.*, Dec. V, p. 24.

[c] The more complicated structure of the gills in the Swordfishes and in one genus of the Mackerel family (*Acanthocybium*), where the several branchial laminæ coalesce into one lamina, meshed like a net, is also probably connected with this circumstance.

[d] *Spolia Atlantica*, l. c., p. 482.

Lütken has proved that the characters on which Cuvier's *Thynnus brachypterus* is based, belong in all probability, simply to juvenile forms of the large Tunny (*Orcynus thynnus*) and that the same author's *Th. coretta* from the West Indies is only an intermediate form between them. To this same species he has also referred Storer's *Th. secundo-dorsalis* from North America and Schlegel's *Th. orientalis* from Japan. Furthermore, he has shown that in *Euthynnus allitteratus* the depth of the body and the height of the dorsal and anal fins eventually increases, and that Cuvier's *Th. brevipinnis* should be regarded as a juvenile form of this species. Finally, he has referred to the same changes of age and collected into one species, which he proposes to call by Lacepède's name *Orcynus germo*, all the long-finned Tunnies known as *Thynnus alalonga*, *Th. albicora*, *Th. germo*, *Th. pacificus*, *Th. argentivittatus*, *Th. balteatus*, *Th. sibi* and *Th. macropterus*.

Merely from these remarks we may conclude that the Scombroids with large jaw-teeth and with the dorsal and anal fins low, only slightly pointed and broken up into only few finlets, may generally be regarded as less advanced in development of form. From the measurements taken by McCoy[a] of different-sized specimens of *Orcynus thynnus* from 18 in. 3 lines to 5 ft. 1 in. in length, we have the following results: the positions of the dorsal, anal, and ventral fins move forward as the fish grows older, and the height of the second dorsal and the anal increases, while the length of the pectoral fins and the snout seems first to increase and then relatively to decrease. The relative length of the head, the dorsal fins, and the anal fin seems also to diminish, though irregularly; and as usual the relative size of the eyes decreases. In the common Mackerel, on the other hand, we find that the position of the posterior dorsal fin in relation to the length of the body moves backward as the fish grows older, while the distance between the front points of the two fins increases. We may thus distinguish between two different directions of development, the one represented by the true Mackerel, the other by the Tunnies. From the latter fishes Cuvier separated the genus *Sarda*[b], which is characterized by the comparatively large size of its jaw-teeth and in this respect is an intermediate form between the genus *Scomberomorus* (*Cybium*) and the other members of the family. Its chief peculiarity is that, like several species of the genus *Scomberomorus*, it displays least alteration in the extent and shape of the first dorsal fin from those of youth. As different directions of development the genera *Echeneis* and *Elacate* are also easy to distinguish, the former having the first dorsal fin changed into a sucking disk, the latter having this fin broken up into free spines. In the Scandinavian fauna only the three first-mentioned branches of development are represented, each by two or three species. The systematic relations of these species to each other may most easily be expressed in the following scheme:

I: Preorbital bone comparatively narrow, leaving at least the greater part of the upper jaw-bone externally visible throughout its length, when the mouth is closed:

A: First dorsal fin anteriorly pointed, with a flap-like point in front. Jaw-teeth comparatively small. Height of the anal fin greater than its length. Genus *Orcynus:*

a: Hind portion of the body and the belly for the most part naked (without distinct scales). Subgenus *Euthynnus:*

α: Ventral sides silvery and either plain or spotted with black .... *Euthynnus allitteratus.*

β: Ventral sides silvery and marked with black longitudinal bands .... *Euthynnus pelamis.*

b: Body covered with scales posteriorly and on the belly as well. Subgenus *Orcynus.* ... *Orcynus thynnus.*

B: The anterior part of the first dorsal fin forms an even, convex or slightly concave curve continued by the posterior part of the upper margin of the fin. Jaw-teeth comparatively large. Height of the anal fin less than its length. Genus *Sarda:*

a: Hind portion of the body and the belly for the most part naked. Subgenus *Orcynopsis* .... *Orcynopsis unicolor.*

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[a] *Prodr. Zool. Vict.*, dec. V, p. 22.

[b] *Rign. Anim.*, ed. 2, p. 199 = *Pelamys*, Cuv., Val., *Hist. Nat. Poiss.*, vol. VIII, p. 149.

b: Hind portion of the body and the belly also covered with scales. Subgenus *Sarda* ..... *Sarda pelamis*.

II: The preorbital bone completely covers the front part of the upper jaw-bone and at least the greater portion of the back part, when the mouth is closed:

A: Hind portion of the body and the belly for the most part naked. Genus *Auxis* .... *Auxis thazard*.

B: Hind portion of the body and the belly also covered with scales. Genus *Scomber* .... *Scomber scombrus*.

Genus **ORCYNUS.**

Body terete and fusiform. In the preabdominal region the scales of the body form a corslet of larger and more firmly fixed scales than on the rest of the trunk. Dorsal fins but little apart from each other, both the anterior and the posterior being highest in front and pointed, with the upper margin deeply concave: second dorsal fin (excluding the finlets) situated, either completely or to a great extent, in front of the anal, which it closely resembles in other respects. Height of the anal greater than the length of its base. Number of finlets behind the dorsal and anal fins from 7 to 10[a]*. Pectoral fins on a level with or sometimes below the eyes. Adipose eyelid comparatively little developed. The preorbital bone leaves the broad, back part of the upper jaw-bone for the most part visible, when the mouth is closed. Jaw-teeth small. On each side of the tail a high, longitudinal middle carina without scales, and at the base of the caudal fin two lower and shorter carinæ, covered with scales and posteriorly converging, one above and one below the middle carina. Pyloric appendages numerous and sometimes united into a glandulous mass.*

Subgenus **EUTHYNNUS.**

Body behind the corslet naked (without scales). Height of the anterior dorsal fin almost double (at least $^{5}/_{3}$*) the length of the snout and greater than the height of the posterior dorsal. Depth of the anal fin about* $^{2}/_{3}$ *(from 60 % to 70 %) of the length of the ventral, which is more than* $^{2}/_{3}$ *(from 70 % to 84 %) of that of the pectoral. Length of the head less than half the distance from the tip of the snout to the second dorsal fin. Eyes of average size. Palatine bones and vomer toothless as a rule, at least the latter, or with small deciduous teeth*[b]*. Hæmapophyses of most of the caudal vertebræ broad at the base and pierced by a large hole which in the anterior part of the tail is so wide that the whole of the hæmapophyses resembles a network hung beneath the bodies of the vertebræ.*

To LÜTKEN belongs the merit of having first given, in his *Spolia Atlantica*, both the external and internal characters which mark this subgenus, which he named *Thynnus s. str.*, a title which he subsequently[c] exchanged, however, for *Euthynnus*. The reduction of the palatine teeth and the scales of the body, as well as the comparatively small size of the head and the great height of the first dorsal fin, seem to indicate that in the development of the Mackerel-type it is this group that has advanced farthest in the direction of the Tunnies, though none of the species known attain so great a size as the true Tunnies. In other respects, however, as for example in the comparatively small height of the anal fin and the fairly great length of the ventral, *Euthynnus* takes the lowest rank among the Tunnies and stands almost on the same level as the true Mackerels. The height of the anal fin in both species seems to vary between 60 % and 70 % of the length of the ventral fins, while in the true Tunnies, as well as in *Pelamis*, it is generally greater than or at least (in youth) equal to the length of these fins.

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[a] During youth the number of anal finlets is only 7; and according to RUPPELL, in *Orcynus bilineatus* there are only 6 finlets on the tail, both above and below.

[b] According to MOREAU, *Euthynnus allitteratus* has teeth both on the palatine bones and on the vomer. STEINDACHNER found no vomerine teeth in his specimen. According to COLLETT there are neither palatine nor vomerine teeth in this species. *Euthynnus pelamis* seems always to be without vomerine teeth.

[c] See JORDAN and GILBERT, *Syn. N. Amer. Fish.*, Bull. U. S. Nat. Mus., No. 16, p. 429.

Like the other members of the genus, the *Euthynni* are pelagic fishes, belonging to the tropic and temperate seas, and only appear as occasional visitors within the limits of the Scandinavian fauna.

THE TUNNINA.

EUTHYNNUS ALLITTERATUS.

Fig. 26.

Distance between the first dorsal fin and the tip of the snout less than 28 % of the length of the body. Height of the posterior dorsal fin about $^1/_4$ of the length of the head. The hind portion of the back steel-blue marked with wavy black bands and spots, which melt into varying figures. The belly silvery, either plain or marked with black spots.

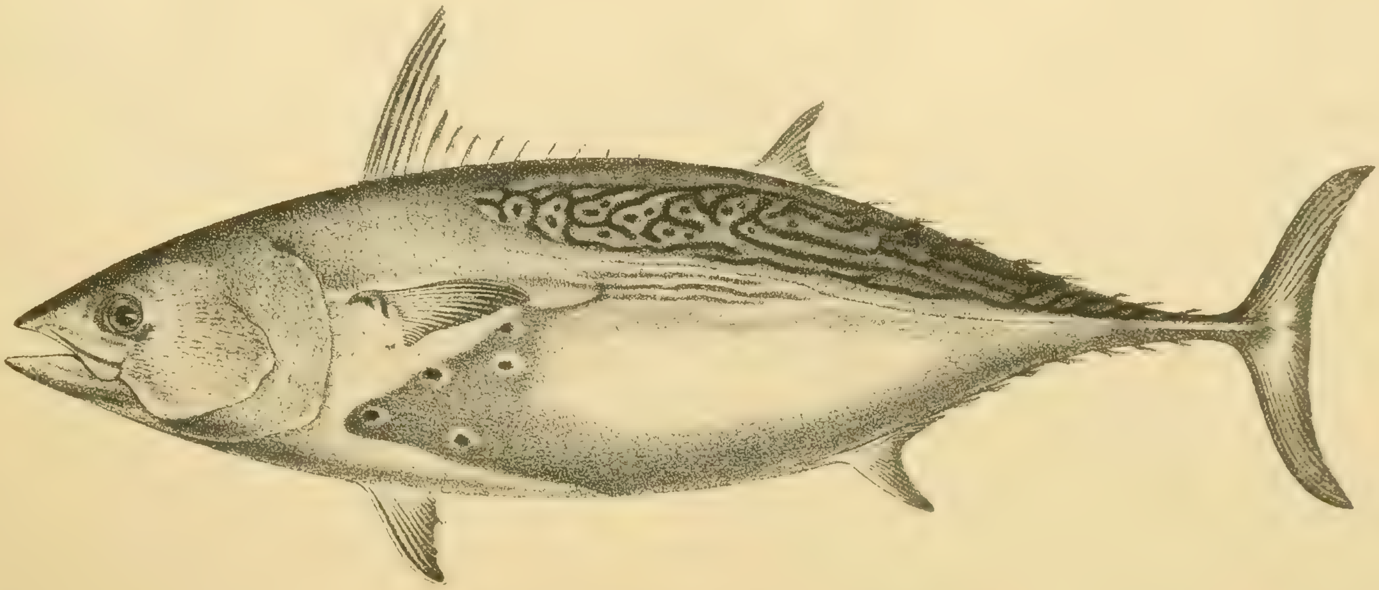

Fig. 26. *Euthynnus allitteratus.* After Nilsson.

R. br. 7; *D.* 15 l. 16 $\frac{1}{10—12}$ VIII l. IX: *A.* $\frac{2\text{ l. }3}{10—12}$ VI—VIII; *P.* 26 l. 27; *V.* $^1/_5$; *C.* $x+18+x$.

Syn. *Scomber allitteratus*, Rafin., *Car. Nuov. Gen.*, p. 46; Jord., Gilb., (*Euthynnus*) *Syn. Fish. N. Amer.*, Bull. U. S. Nat. Mus., No. 16, p. 430.

Scomber Commersonii, Risso, *Ichth. de Nice*, p. 163.

Scomber quadripunctatus, Geoffr., *Descr. de l'Egypte*, *Poiss.*, tab. 24, fig. 5.

Scomber leachianus, Risso, *Eur. Mér.*, vol. III, p. 416.

Scomber thunina, Cuv., *Règn. Anim.*, ed. 2, vol. II, p. 198; Cuv., Val., (*Thynnus thunnina*) *Hist. Nat. Poiss.*, vol. VIII, p. 104, tab. 221; Id. (*Scomber*) *Règn. Anim. Illustr.*, *Poiss.*, p. 118, tab. 46, fig. 1; Schleg. (*Thynnus*) *Fn. Japon.*, 4, *Pisces*, p. 95, tab. 48; Gthr, *Cat. Brit. Mus.*, *Fish.*, vol. II, p. 364; Nilss., Öfvers. Vet.-Akad. Förh. 1863, p. 499, tab. 5; Malm, *Gbgs, Boh. Fn.*, p. 416; Ltkn, Vid. Meddel. Naturh. For. Kbhvn. 1879—80, Heft. 3. Öfvers. Vid. Möd., p. II; Winth., Naturh. Tidskr. Kbhvn., ser. III, vol. XII, p. 14; Id. *Zool. Dan.*, *Fiske*, p. 24; Mor., *Hist. Nat. Poiss. Fr.*, vol. II, p. 421; Coll., Forh. Vid. Selsk. Christ. 1882, No. 19, p. 1; Lillj. (*Orcynopsis*) *Sv., Norg. Fiskar*, vol. I, p. 270; Coll. (*Euthynnus*) N. Mag. Naturv., Bd. 29 (1884), p. 58.

Thynnus brevipinnis, Cuv., Val., l. c. p. 112 (Cf. Lütken, *Spol. Atl.*, l. c., p. 467).

Thynnus brasiliensis, Cuv., Val., l. c., p. 110 (Cf. Gthr. Cat. l. c.).

Thynnus affinis, Cantor (Cf. Day, *Fish. Ind.*, p. 252; Ltkn, *Sp. Atl.*, l. c., p. 467).

Cuvier states that the distinction between the Tunnina and the Tunny was known to Aristotle; and he also refers to this species Aldrovand's *Pelamis coerulea*. Before Cuvier's time Rafinesque and Risso had given descriptions of this fish, and Geoffroy St. Hilaire the best figure then drawn. However, it is much less known than the Tunny, though it has the same wide range, having been found in Japan, the Indian Ocean, the Red Sea, the Mediterranean, Brazil, and on the east coast of North America.

The Tunnina never attains the same size as the Tunny. Risso gives 8 dm. as its greatest length. The specimen from Limhamn described by Nilsson is 83 cm. long. The body is perfectly fusiform, a little more elongated backward than forward. In his *Spolia Atlantica* (l. c., p. 466) Lütken has given some measurements of two specimens, which on comparison with Nilsson's measurements give the following indications of the changes due to age:

				Average.
Length of the body in millimetres	831	620	380	604
.. .. .. head .. % of the length of the body	24.0	25.0	25.3	24.8
Height ,, ,, first dorsal fin ,, ,, ,, ,, ,, ,, ,, ,,	13.8	13.4	12.6	13.3
.. .. ,, ... ,, head	56.2	53.5	50.0	53.2
.. .. .. second .. .. ,, body	6.3	6.6	5.8	6.2
.. .. head	26.5	26.5	22.9	25.3
.. .. .. anal .. .. body	(6.0)	7.0	6.3	(6.4)
.. .. head	(25.0)	27.8	25.0	(25.9)
Length .. .. pectoral .. .. body	13.8	13.7	13.7	13.7
.. .. .. ventral	10.4	9.8	10.5	10.2
Greatest depth of the body	—	25.8	23.7	(24.7)
Diameter of the eye .. .. head	(14.1)	12.9	15.6	(14.2)
Distance between the first dorsal fin and the tip of the snout in % of the length of the body	26.9	—	—	—
Length of the head in % of the distance between the first dorsal fin and the tip of the snout	90.0	—	—	—
Diameter of the eye in % of the length of the snout	47.4	—	—	—

Among the most marked alterations due to age which appear from this table, is the increase in height of the two dorsal fins, especially of the first, in proportion to the length of the head. In this respect, and also in the forward position of the first dorsal fin, the Tunnina is the most developed of its family.

The manner of life of this species, of which we have only the most scanty information, probably differs but little from that of the true Tunny, and it is taken together with the latter in the Italian *madragues*. Its flesh is said to be of a fine red colour and of good flavour; but like that of the other Tunnies it decomposes rapidly and then, of course, becomes unwholesome.

From its true home this fish has occasionally wandered to Scandinavian waters. One specimen was caught on the 29th of July, 1857, in the Sound off Limhamn near Malmö, and is now preserved in the University Zoological Museum at Lund. Another was taken near the same place, off Humlebæk, in a bottom-net in October, 1878, and in August, 1881, four specimens were caught in a herring-net among the islands off Christiania.

THE BONITO (SW. BONITEN.)

EUTHYNNUS PELAMIS.

Fig. 27.

Distance between the first dorsal fin and the tip of the snout more than 30 % of the length of the body. Height of the posterior dorsal fin more than 33 % of the length of the head. Back steel-blue without stripes; belly with 4 or 5 dark longitudinal bands.

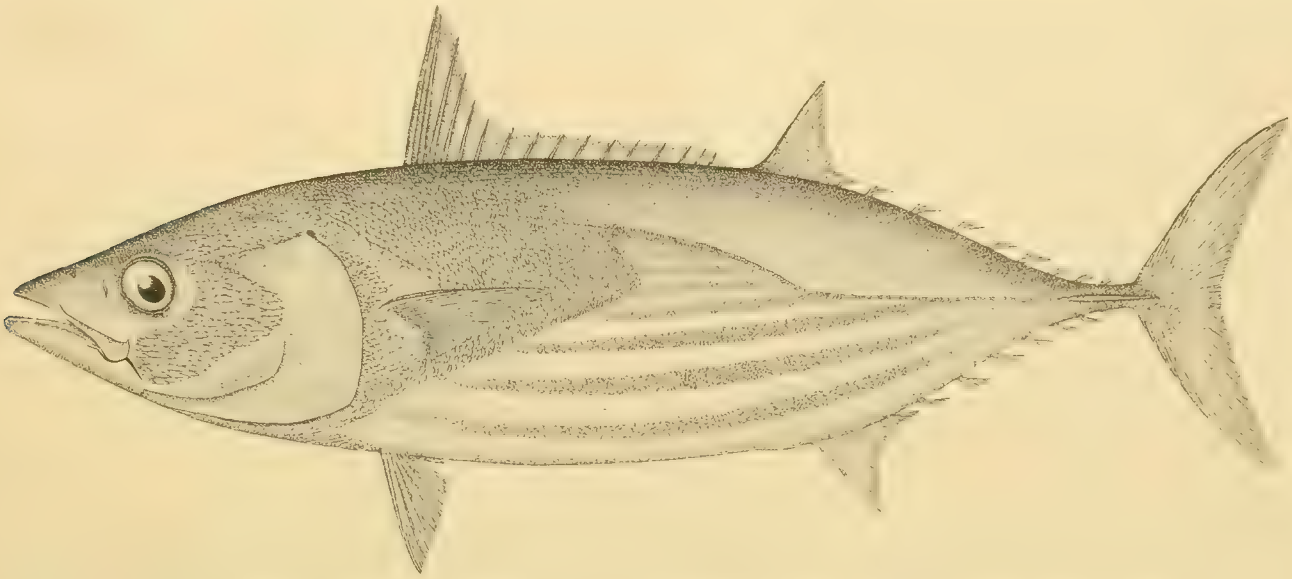

Fig. 27. Bonito (*Euthynnus pelamis*) from the Cattegat off Varberg. $^1/_3$ of the natural size.

R. br. 7; *D.* 15 l. $16\frac{1-3}{12}$ VIII; *A.* $\frac{2\text{ l. }3}{12}$/ VII;
P. 2 + 26 l. 27; *V.* $^1/_5$; *C.* $x + 18 + x$.

Syn. *Scomber pulcher*, Osb., *Ost. Resa*, p. 67 et in registro.
Scomber Pelamis, Lin., *Syst. Nat.*, ed. X, p. 297; Cuv., Val., (*Thynnus pelamys*), *Hist. Nat. Poiss.*, vol. VIII. p. 113, tab. 214; Schleg., *Fn. Japon.*, *Pisces*, p. 96, tab. XLIX; Gthr, *Cat. Brit. Mus.*, *Fish.*, vol. II, p. 364; Malm, Öfvers. Vet.-Akad. Förh. 1875, No. 7: p. 3, tab. 9; Id., *Gbgs*, *Boh. Fn.*, p. 416; Reinh. apud Ltkn, *Spol. Atl.*, l. c., p. 465; Gigl., *Elenco* etc., Esp. Int. di Pesca in Berlino 1880, Sez. Ital., Cat., p. 85; Mor., *Hist. Nat. Poiss. Fr.*, vol. II. p. 419; Day, *Fish. G:t Brit.*, *Irel.*, vol. I, p. 100, tab. 37; Lillj. (*Orcynopsis pelamis*) *Sv.*, *Norg. Fisk.*, vol. I, p. 274; Jord., Gilb., (*Euthynnus pelamys*) *Syn. Fish. N. Amer.*, Bull. U. S. Nat. Mus., No. 16, p. 430.

In the form of the body this species resembles the preceding one. The chief differences consist in the less forward position of the dorsal fin, the greater height of the second dorsal and the greater length of the head. From these differences we may see, as is often the case, that one character may be highly developed, while in other respects the species ranks low in the scale of the generic development.

In size it is about equal to the preceding species, the greatest length being given as 8 dm. For purposes of comparison between the two species we here give, according to Malm's measurements, the following table:

			Average.
Length of the body in millimetres	782	488	635
„ „ „ head „ % of the length of the body	27.5	27.5	27.5
Height „ „ first dorsal fin „ „ „ „ „ „ „ „	14.0	13.1	13.5
„ „ „ „ „ „ „ „ „ „ „ „ „ „ head	51.1	47.7	49.4
„ „ „ second „ „ „ „ „ „ „ „ „ body	9.9	—	—
„ „ „ „ „ „ „ „ „ „ „ „ „ „ head	36.3	—	—
„ „ „ anal „ „ „ „ „ „ „ „ body	7.1	—	
Length „ „ pectoral „ „ „ „ „ „ „ „ „	14.1	13.3	13.7
„ „ „ ventral „ „ „ „ „ „ „ „ „	10.8	11.0	10.9
Greatest depth of the body „ „ „ „ „ „ „ „	26.8	24.6	25.7
Diameter of the eye „ „ „ „ „ „ „ head	—	14.2	—
„ „ „ „ „ „ „ „ „ „ „ snout		51.3	—
Distance from the first dorsal fin to the tip of the snout in % of the length of the body	32.0	31.1	31.5
Length of the head in % of the distance from the first dorsal fin to the tip of the snout	86.0	88.1	87.0
Distance from the second dorsal fin to the tip of the snout in % of the length of the body	61.1	61.1	61.1
Length of the head in % of the distance from the second dorsal fin to the tip of the snout	45.0	45.0	45.0
Distance from the anal fin to the tip of the snout in % of the length of the body	65.7	65.1	65.4
Distance from the ventral fins to the tip of the snout in % of the length of the body	—	29.3	—

The back is a bright steel-blue with a greenish and reddish gloss. The belly silvery with several longitudinal brown bands, generally four, but sometimes five or six, on each side, which run parallel to each other from the front of the belly to the posterior part of the lateral line, the caudal fin and the lower margin of the tail.

The Bonito[a] is one of the fishes most often observed within the tropics. Like the large Tunnies and the Dolphins (*Coryphæna*) but with even greater eagerness, it hunts the Flying-fish, and in pursuit of its prey often leaps high out of the water. We also know that it sometimes hunts the Cuttle-fish. Its flesh is eaten, "though it is dry enough", writes Osbeck; and it is caught in the following manner: "A small fish is fashioned of tin or lead and fastened to a large hook. On opposite sides of the hook are fixed the tips of a pair of feathers to imitate a flying-fish; another pair of feathers are used to represent the caudal fin. The line is passed through the head of this imitation fish, and taking his seat on the bowsprit or some other part of the vessel, the fisherman waves the bait to and fro above the water with his rod, till the fish bites. The Bonito is also struck with the harpoon".

Within the tropics the Bonito is spread all round the world, and in the temperate seas it goes at least as far as round the Cape of Good Hope. In Japan it is caught in great numbers and as an article of food is in much request. In the Mediterranean it is apparently rare, as off the coasts of England and the east coast of North America. Here in the North its food consists principally of Herrings, Anchovies and Sauries. It was probably in pursuit of the herring-shoals that it wandered in 1873 into the Cattegat, where a specimen was taken near Oroust on the 13th of October, and another off Varberg in September, 1875, the only two Bonitos as yet known to have been caught in Scandinavian waters. Both have been described by Malm.

Subgenus **ORCYNUS**.

Body behind the corslet covered with scales. Height of the anterior dorsal fin equal to or less than the length of the snout and (in adult specimens) less than the height of the posterior dorsal. Height of the anal fin (in adult specimens) equal to or greater than the length of the ventral fins, which is less than $^2/_3$ (from 50 % to 60 % at most) of that of the pectoral. Length of the head at least half the distance from the tip of the snout to the posterior dorsal fin. Eyes small. Small, but numerous, cardiform teeth on the palatine bones and the vomer. Hæmapophyses of the caudal vertebræ normal in form and structure.

The Greeks gave the Tunny the names of **Θύννος** (Aristot.), **Ὀρκύνος** (Ælian.) and **Μελάνδρυς** (Athen.). As the first name was first employed systematically by Fabricius among the Hymenoptera, the current laws of nomenclature enjoin the employment of the name *Orcynus* for this genus. The same name was also used by CUVIER on one occasion[a] for a subgenus which included the long-finned Tunny (Albicore: *Orcynus germo*), but was afterwards[b] rejected by him on the ground that all the Tunnies should be referred to one single genus (*Thynnus*). It has, however, been subsequently restored by GILL[c] for the reasons given above.

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[a] "From the Spanish *Bonito*, beautiful", says Osbeck.

The subgenus *Orcynus* contains the largest members of the family and those in many respects with the most marked characters within the limits of the Mackerel-type; but according to LÜTKEN's well-founded arguments we may accept only two species as known. One of these has wandered fairly often within the boundaries of the Scandinavian fauna.

THE TUNNY (SW. TUNFISKEN OR MAKRILSTÖRJEN).

ORCYNUS THYNNUS.

Fig. 28.

The pectoral fins, when laid back, do not extend farther than the end of the first dorsal fin.

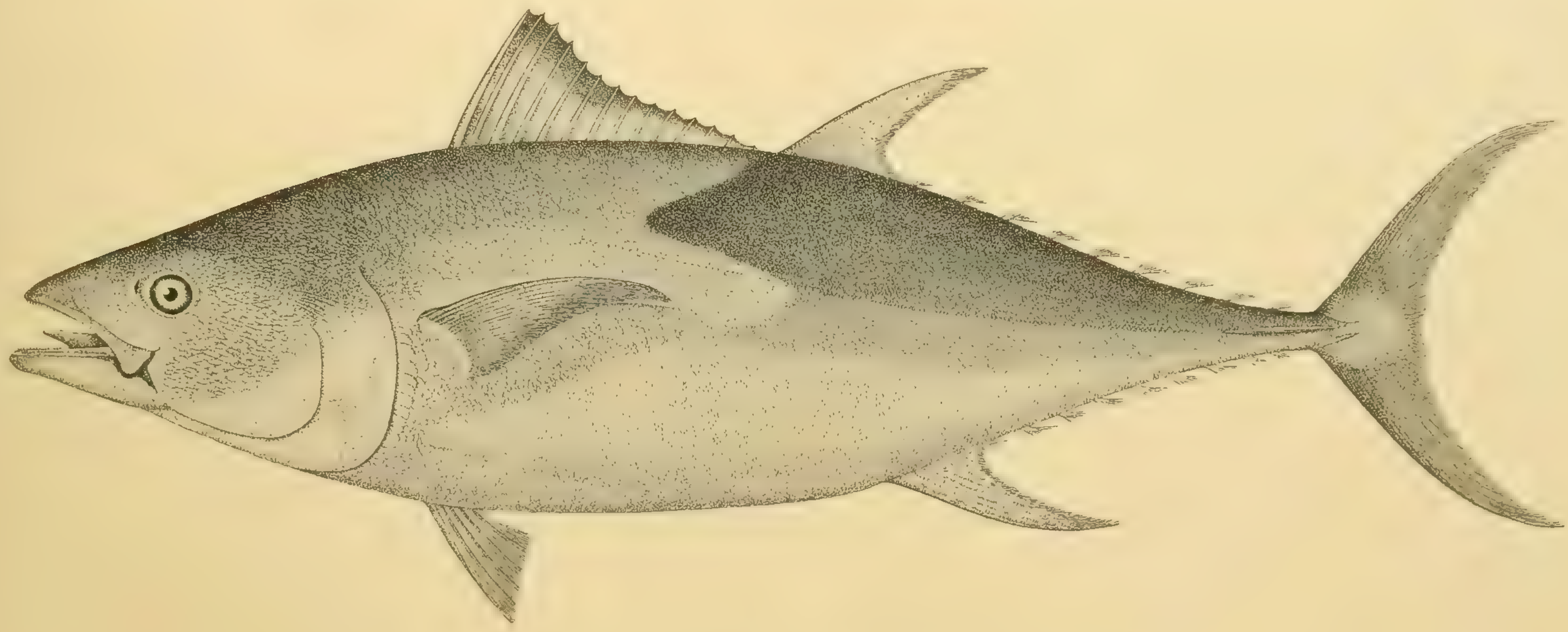

Fig. 28. Tunny (*Orcynus thynnus*) from Bohuslän. $^1/_{12}$ natural size.

R. br. 7; *D.* 13 l. 14 $\frac{1}{13\ \mathrm{l.}\ 14}$ VIII—X; *A.* $\frac{2}{12}$ VIII l. IX; *P.* 2 + 31 l. 32; *V.* $^1/_5$; *C.* $x. + 18$[d] $+ x.$

Syn. *Θύννος*, *Πηλαμὺς* et *Κορδύλος*, ARIST.; *Ὀρκύνος* et *Πήλαμυς*, ÆLIAN.; *Ὄρκυνος* et *Μελάνδρυς*, ATHEN.: vide ARTEDI, *Syn.*, p. 49 et CUV., VAL., *Hist. Nat. Poiss.*, vol. VIII, pp. 77—79.

Scomber Thynnus, LIN., *Syst. Nat.*, ed. X, tom. I, p. 297; RETZ., *Fn. Suec. Lin.*, p. 340; HOLLBERG, *Boh. Fisk.*, III, p. 1 cum tab., Gbgs Vet., Vitt. Samh. N. Handl., V (1822): NILSS., *Prodr. Ichth. Sc.*, p. 83: SUNDEV., Öfvers. Vet.-Akad. Förh. 1844, pp. 11 et 214; GTHR (*Thynnus*), *Cat. Brit. Mus.*, *Fish.*, vol. II, p. 362; WINTH., *Prodr. Ichth. Dan.*, Naturh. Tidskr. Kbhvn., ser. III, vol. XII. p. 13; ID., *Zool. Dan.*, *Fiske*, p. 23, tab. IV, fig. 4; McCOY.

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[a] *Règn. Anim.*, ed. 2, tome II, p. 198.

[b] CUV., VAL., *Hist. Nat. Poiss.*, vol. VIII, p. 120.

[c] Proc. Acad. Nat. Sc. Philad., 14 (1862), pp. 125 and 329.

[d] The difficulty of counting the rays in stuffed specimens renders the correctness of this formula uncertain.

Prodr. Zool. Vict., dec. V. p. 21, tab. 44, fig. 2; Ltkn (*Orcynus*). *Spol. Atl.*, Vid. Selsk. Skr. Kbhvn., ser. 5. Naturv. Math. Afd., XII, No. 6, p. 460; Day, *Fish. G:t Brit., Irel.*, vol. I, p. 93, tab. 35; Mor. (*Thynnus*). *Hist. Nat. Poiss. Fr.*, vol. II, p. 422; Lilli. (*Orcynus*). *Sc., Norg. Fiskar*, vol. I, p. 240; Coll., N. Mag. Naturv. 1884, p. 58.

Thynnus mediterraneus, Risso, *Eur. Mér.*, vol. 3, p. 414; Coll., Vid. Selsk. Forh. Christ. 1874, Tillægsh., p. 44; ibid. 1879, p. 20.

Thynnus vulgaris, Cuv., Val., l. c., p. 58, tab. 210; *Règn. Anim. Illustr., Poiss.*, p. 117, tab. 45, fig. 2; Kroy., *Danm. Fiske*, vol. I, p. 237; Ekstr., Gbgs Vet. Vitt. Samh. Hand., N. Följd, H. 1 (1850), pp. 23 et 37; Nilss., *Skand. Fn., Fisk.*, p. 139; Cederstr., Öfvers. Vet.-Akad. Förh. 1876, No. 4, p. 64; Möb. et Heincke, *Fische d. Ostsee*, p. 39.

Thynnus brachypterus, Cuv., Val., l. c., p. 98 (Cf. Lütken, *Spol. Atl.*, l. c., p. 462).

Thynnus coretta, Cuv., Val., l. c., p. 102 (Cf. Ltkn, l. c., p. 463).

Thynnus secundo-dorsalis, Storer, Mem. Amer. Acad. A. a. Sc., vol. V, p. 143, tab. XII, fig. 4 (Cf. Ltkn, l. c., p. 464).

Thynnus orientalis, Schleg., *Fn. Japon, Pisc.*, p. 94 (Cf. Ltkn, l. c.).

Thynnus Linnei, Malm, *Gbgs, Boh. Fn.*, p. 412.

The Tunny is one of the largest fishes to which the Scandinavian fauna can lay claim. Specimens 3 metres in length are taken off the coast of Norway[a]. Risso gives its length in the Mediterranean as 5 metres, and according to Storer a specimen 15 feet long was taken in 1838 off Cape Ann, Mass., while Brown-Goode[b] adds that still larger specimens are on record. When 2 metres in length, according to Moreau, the Tunny weighs about 153 kilo.

The body is fusiform and thickest in the preabdominal region about half-way along the pectoral fins: the breadth is $^{3}/_{4}$ of the depth. It tapers much more gradually backwards than forwards. The greatest depth, according to McCoy's measurements, varies between 23 % and 29 % of the length. The length of the head and the greatest depth of the body are sometimes equal, but the former is generally the greater, varying between 30 % and 28 % of the length of the body, or 50 % and 55 % of the distance from the tip of the snout to the beginning of the second dorsal fin. The last measurement varies between 58 % (in the young specimens) and 51 % (in the old) of the length of the body. The scales of the body, especially on the posterior part, are covered with an outer skin (epidermis), which renders them more or less indistinct; and the difference in size between the scales of the hind parts and those of the preabdominal region is very marked. In the corslet we may find scales 12 times as broad as those on the posterior part of the body, for a row of 12 scales on the ventral side above the base of the anal fin is equal in size to the externally visible part of one of the larger scales in the corslet. The latter are further distinguished by their considerably greater thickness and firmer structure. On the margin of the corslet appear several sinuses and prolongations. One prolongation runs along the dorsal fins, and may extend as far as the termination of the second dorsal; another runs along the middle of the side, passing the point of the pectoral fins and furnished with a groove to receive them when they are folded, and extends under the base of the second dorsal fin. A third prolongation runs on each side of the body in the region of the ventral fins and extends back about as far as a perpendicular from the point of the pectoral. In the region of this prolongation lie the hollow and the groove to receive the ventral fins. Of the two sinuses between these three prolongations the upper is the shallower, but it sometimes extends forward to the middle of the first dorsal fin; the lower lies between the pectoral and ventral fins. These limits, however, are often very indistinct. As is generally the case in this family, the head is naked for the most part, with the exception of the cheeks, which are covered with lanceolate scales beneath the skin, and the sides of the occiput, where the corslet extends forwards in the form of an acute-angled triangle over each temple as far as the posterior margin of the eye, leaving between these two triangles a naked wedge-shaped space pointing backwards and extending as far as a perpendicular from the upper corner of the gill-opening. The high, middle carina on each side of the tail, which begins between the antepenultimate and the penultimate anal finlets, is also naked. The smaller lateral carinæ on the tail, two on each side, which converge posteriorly, are, on the contrary, covered with scales, as in the common Mackerel.

The eyes are comparatively small. According to McCoy's measurements of specimens from 463 to 1,778 mm. in length, their longitudinal diameter varies between 17 % (in young specimens) and 11·5 % (in old) of the length of the head or between 48 % and 32 % of the length of the snout. The adipose eyelid, which is sometimes scarcely distinguishable, forms an oval opening for them. The anterior nostril is a small round hole on a level with the superior margin of the eye and about half-way between the eye and the tip of the snout: the posterior nostril, as is generally the case in the family, is a narrow perpendicular slit, its distance from the eye and its length being about equal to the diameter of the pupil. The lower margin of the operculum and the hind margin of the interoperculum meet at the middle of the curved posterior margin of the preoperculum in almost the same curve, the one upwards and the other downwards, over the exterior of the suboperculum, the hind margin of which forms the greater part of the posterior edge of the gill-opening. The interoperculum, which forms the whole lower edge of the gill-opening, is of about the same length as the lower jaw. When the gill-openings are closed, the one interoperculum touches the other or even overlaps it.

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[a] "The largest specimens may be more than 10 feet (5 Danish yards) in length", says Ström, *Sondm. Beskr.*, part 1, p. 311.

[b] *Fish. Industr.*, part I, p. 320. N. B., the figure of this fish given in Plate 96 in all probability really represents an *Auxis*.

The height of the unpaired fins varies with age, the second dorsal and the anal fins being lower in youth than the first dorsal, while in old specimens they are higher than it. Their height varies, according to McCoy between 9 % and 12 % of the length of the body. The relative length of the dorsal and anal fins, on the contrary, diminishes with age: the length of the first dorsal sinks, according to McCoy from 23 % to 21 % of the length of the body, and its distance from the tip of the snout from 33 % or 35 % to 30 %. The length of the pectoral fins increases during youth, but afterwards diminishes with age from 20 % to 15 % of the length of the body, as is the case even with the Royal Museum's specimen 236 cm. in length. The length of the ventral fins, on the other hand, increases, both according to McCoy's measurements and according to the specimen in the Royal Museum, from 8 to 10 % of the length of the body.

Of the internal organs the pyloric appendages and the air-bladder are especially remarkable. The former are 5 in number and branched repeatedly. They are sometimes[a] so surrounded and united with fat and blood-vessels by a connective tissue that they form a large gland. The air-bladder, according to Malm[b], has two large, elongate processes in front and two smaller ones behind[c].

The colouring is a more or less dark, lustrous blue on the back, and on the sides and belly gray, sometimes thickly strewn with large silvery spots. The first dorsal, the pectoral and the ventral fins dark brown, the caudal a lighter brown. The second dorsal and the anal fins orange, the finlets yellow edged with black. Such is Moreau's description of the colouring of the Tunny.

Even in classic times the Tunny had won a high position in the economy of the Greeks and Romans. It was chiefly at each end of the Mediterranean, off the Pillars of Hercules (Gibraltar) and in the Hellespont (Constantinople), that large fish of this species were then found. The Phoenicians are said to have introduced the Tunny-fishery into Spain on each side of Gibraltar; and the Golden Horn of Constantinople is said to have received its name on account of the abundance of Tunnies which were caught there. It was known that yearly, in spring, it entered the Black Sea in order there to propagate its species — Strabo gives the Maeotic swamp (the Sea of Azov) as the locality. The small Tunnies, when they left the Black Sea in their first autumn, were known as *Kordylos* and *Auxis*, when they returned, they were called *Pelamis*. The largest were called *Orcynus;* and according to Athenæus, it was thought that they came into the Mediterranean from the Atlantic, but never went further than Italy. *Melandrys* was a name originally used for the sliced flesh of the Tunny, and *Cybium* for the cubical bits of flesh cut from young Tunnies.

Duhamel[d] and Cetti[e] have given minute descriptions of the Tunny-fishery of later times. At the present time it is not believed that even the majority of the Mediterranean Tunnies are annual visitors from the Atlantic, though their immigration and emigration through the Straits of Gibraltar cannot be denied. Even in winter they are caught in the Mediterranean, though at this season they withdraw to the deepest waters. Not before spring do they again approach the shore; and they are then caught in large quantities in seines, chiefly in France and Spain — and also in the Atlantic, where this fishery is more desultory — in *madragues* off the coast of Italy, chiefly in Sardinia and Sicily, and in *matanzas* in Tunis. The last two engines, which closely resemble each other, consist of a series of nets fixed at a depth of at least 18 fathoms, on the same principle as the Swedish traps for Perch (*ryssjor*, fig. 4, p. 33) or netted pens (*pator*) for Salmon, or the ground-nets (*bottengarn*) used in the Sound. This principle, which is employed, though with several modifications, by all fishing nations, is founded on the observation that fish, at least when collected in shoals, keep the same course and coast any obstacles that may meet them in the same direction, provided they are not suddenly frightened. One arm of the net is drawn towards the shore and another out to sea in order to guide the fish into the chambers, which correspond to the netted pen or the divisions of the Perch-traps. The last chamber, called the chamber of death, has a net at the bottom, which is raised, like the chamber of the ground-net, when the catch is to be taken. The murderous slaughter which now ensues is in some places a public amusement[a], and several hundred fish are often taken at a haul. In the island of St. Pierre off the south coast of Sardinia, 15,850 Tunnies were taken by this method in 1866: their total weight was about 1,255 tons and they were valued on the spot at about £51,000. The fishing goes on even in autumn up to the end of October, when the Tunnies wander in the opposite direction and are therefore supposed to be endeavouring to make their way out into the Atlantic. The flesh is highly valued in the countries bordering on the Mediterranean. The different parts of the fish are of different appearance and flavour. The slices from the belly (*sorra*) are considered most delicate. One part of the flesh is preserved in oil (*scabeccio*), another salted, and the head, bones and offal are boiled down into train-oil. The roe, too, is highly esteemed. It is sometimes made into *bottarga*, a kind of salted and pressed caviare. The best *bottarga*, however, is obtained from the Grey Mullet. Good and wholesome as the flesh of the Tunny is when fresh or well preserved, it is no less harmful when this is not the case, as it decomposes rapidly.

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[a] According to Cuvier's description of *Thynnus vulgaris*, l. c., p. 66. In *Thynnus brachypterus*, according to his description, the connective tissue in wanting. The difference is perhaps no more than that which often occurs in fishes, e. g. the Salmon and Gwyniad, before and after the spawning season, and is due to the greater or less accumulation of fat round the pyloric appendages.

[b] l. c., p. 415.

[c] Cf. Lilljeborg, l. c., p. 252.

[d] *Traité d. Pêches*, part II, sect. VII, chap. II.

[e] *Naturg. v. Sardinien*, 3:ter Th. pp. 141 etc.

In the Scandinavian fauna the Tunny can only be regarded as an occasional visitor, though it often crowds "in large shoals" (Coll.) into the Norwegian fjords as far north as the Lofoden Islands. Ström (l. c.) informs us that in the last century it was often taken partly in the herring-nets among the summer Herrings, and partly with the harpoon, the latter instrument being used chiefly in Jørgen Fjord (a branch of Stor Fjord in Söndmör), and that its flesh, which was fat as bacon, was regarded as a delicacy by the peasants. No fry, however, to prove that it propagates its species in Norway, have ever been found, so far as we know[b]. Off the coast of Bohuslän the Tunny is seldom caught, though, according to Cederström, it is not rare on the north coast during summer. Hollberg described in 1822 (l. c.) a specimen 172 cm. in length, which had been caught eight years before in the River Gotha just where it passes the Old Town (a part of Gothenburg). Ekström presented to the Royal Museum a specimen 236 cm. in length, which was found dead on the 23rd of August, 1844, in the island-belt of Tjörn (Bohuslän). Malm mentions a specimen taken off the rock of Gåsö, outside Gullmaren, in the autumn of 1851, which was only a little smaller than another $248\frac{1}{2}$ cm. long, which was found by some fishermen "entangled in seaweed" in the Skager Rack on the 15th of October, 1867. In September, 1887, on an islet at the mouth of the Dynekil not far from Strömstad, "a specimen of the Tunny was cast ashore which was nearly 27 dm. in length; the length of the head from the gills to the point of the lower jaw was 700 mm." (C. A. Hansson). The Tunny has been met with on numerous other occasions in the Cattegat, the Sound, the Great Belt and even in the Baltic[c]. It has twice been taken off Ystad, in 1709 and in October, 1878, and once off Östra Torp at the most southern point of Sweden. In 1869 a Tunny was caught off Stralsund, and the species has been met with several times in the south-west corner of the Baltic and in the Sound.

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[a] Cf. Brehm, *Thierleben*, 2nd. ed., Abth. III, Bd. 3, p. 97.

[b] Though Hofmann relates in Tidskr. f. Naturv. Kbhvn., II, p. 365, that a Tunny as large as a Mackerel, i. e. 3 or 4 months old, has been caught off the north coast of Fünen, Kroyer, who quotes this find (l. c., p. 250), seems to doubt its accuracy.

[c] See Kroyer, Nilsson, Winther and Möbius and Heincke.

In October, 1843, a specimen became stranded in the shallows off Saltholm in the Sound, and of this specimen the Royal Museum has acquired the left suboperculum, which measures 305 mm. along the free part (not covered by the operculum and interoperculum) of the hind margin, a scale from the corslet and several fin-rays, all described by Sundevall (l. c.). The size of the suboperculum shows that the fish was about 269 or 273 cm. (8 ft. 7 in. or 8 ft. 9 in.) in length.

As appears from the list of synonyms, the Tunny is also known not only in the W. Indies (*Thynnus coretta*), and on the coast of Massachusetts (*Th. secundodorsalis*), but also in Japan (*Th. orientalis*) and Australia (*Th. thynnus*, McCoy).

The Tunny is an active and voracious fish, but in spite of its great size very timid. When the Raïs, the master of the *madrague*, wants to drive the Tunnies in the depths of the *madrague* from chamber to chamber, he drops a handful of sand into the water, and the fishes dart away, says Cetti, as though the sky had fallen on them. If this expedient does not succeed, especially when he has to drive them into the chamber of death, he lets down a black sheep-skin, which seldom fails to do its work. The sailor may often see his vessel followed for long distances by Tunnies seeking its shadow. No doubt the fish snap up whatever is thrown to them and bite freely at a hook baited with Herring or something of the kind, at least so long as there is any way on the vessel; but they follow it so persistently even without these allurements that it has been suggested as the most probable explanation of their conduct that they endeavour to hide from their enemies, chiefly from the Sharks. In the Mediterranean, too, it is said that, when frightened, they try to conceal themselves in the seaweed. Still the Tunny pursues its own victims rapidly and eagerly. These consist principally of Herrings or, in the Mediterranean, Anchovies and Sardines, Mackerel, Flying-fish, Sauries and Garpike. It is interesting to see how the Flying-fish endeavour to escape its attack: the Tunny follows them during their flight, but does not leap out of the water in pursuit of them as it does when it chases the Sauries.

The spawning-season of the Tunny is in summer. In April and the beginning of May, when the Tunny-fishing first begins in Italy, one can scarcely distinguish the eggs in the ovaries, which at this time weigh about $4^{1}/_{4}$ kgrm. in large specimens, whereas some days after in specimens of equal size they weigh about $42^{1}/_{2}$ kgrm. before they are fully ripened[a]. In the middle of June the Tunnies, driven by instinct to propagate their species, may be seen incessantly leaping and swimming about in the bays and laying their eggs among the seaweed, where they are fecundated by the males. "When the Tunnies sport round the females in burning desire," says Risso[b], "they are bright with a blaze of shifting colours; their whole body is covered with golden spots, which vanish at the end of the spawning-season." In the month of July the newly hatched fry weigh about 42 gm., in August 113 gm., and in October they have reached a weight of 848 gm.

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[a] According to Duke C. d'Amico of *Ossada*, quoted by Cuvier, (Cuv., Val., l. c., p. 84).

[b] *Eur. Mér.*, l. c., p. 418.

GENUS SARDA.

Body round and fusiform or somewhat compressed or elongated. The scales of the body form a corslet in the preabdominal region. Dorsal fins only a little apart, the anterior part of the first being not at all or only slightly elevated and forming an even, convex or slightly concave continuation of the hind part of the upper margin of the fin: the second, which is generally lower than the first[a]*, being for the most part situated in front of the anal, to which it is similar in other respects. Height of the anal greater than its base. Finlets behind the dorsal and anal fins from 7 to 9. Pectoral fins set near the middle point in the height of the body. Length of the ventral usually under 8 % of the length of the body*[b]*. Length of the head less than half the distance between the tip of the snout and the second dorsal fin. Eyes small, the adipose lid but little developed. The preorbital bone does not conceal the broad, posterior part of the upper jaw-bone when the mouth is closed. Jaw-teeth comparatively large. On each side of the tail a naked, long and high, longitudinal middle carina, and at the extremity of the tail two smaller, scaly carinæ, which converge posteriorly. Pyloric appendages numerous, and sometimes united into a glandulous mass.*

SUBGENUS ORCYNOPSIS.

Body behind the corslet naked (without distinct scales). Height of the anal fin nearly 10 (9·5 to 9·8) % of the length of the body. Length of the ventral fins a little more than half (from 54 to 56 %) of the height of the anal and about $^{2}/_{5}$ *(from 40 to 42 %) of the length of the pectoral. Length of the head, as well as the distance between the tip of the snout and the first dorsal fin, less than* $^{1}/_{4}$ *of the length of the body. Length of the pectoral fins generally more than half (from 57 % to 61 %) the length of the head: length of the ventral less than or, at most, equal to* $^{1}/_{4}$ *of the length of the head. Palatine bones and vomer with teeth.*

Of the subgenus *Orcynopsis* only two species are known, or perhaps only one, as there is good reason to doubt the distinctions between them given by the authors.

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[a] In *Orcynopsis unicolor*, according to MOREAU, the posterior dorsal fin is higher than the anterior, as in the specimen of this species which we have been able to examine, in which, however, the rays of the first dorsal are bent and somewhat damaged. Still MOREAU'S specimen, as well as ours, was stuffed, a circumstance which inclines me to rely on COLLETT'S examination of perfect specimens preserved in spirits, though the possibility of a difference in this respect due to sex or age cannot be denied.

[b] According to STEINDACHNER, the length of the ventral fins in *Sarda chiliensis* goes as high as nearly 13 % of the length of the body.

THE PLAIN PELAMIS.

ORCYNOPSIS UNICOLOR.

Fig. 29.

Back dark steel-blue. Belly silvery. No distinct stripes or bands in the colouring of the body (in adult specimens). Mandible about as long as the base of the anal fin or the length of the pectoral, or even a little shorter than the latter.

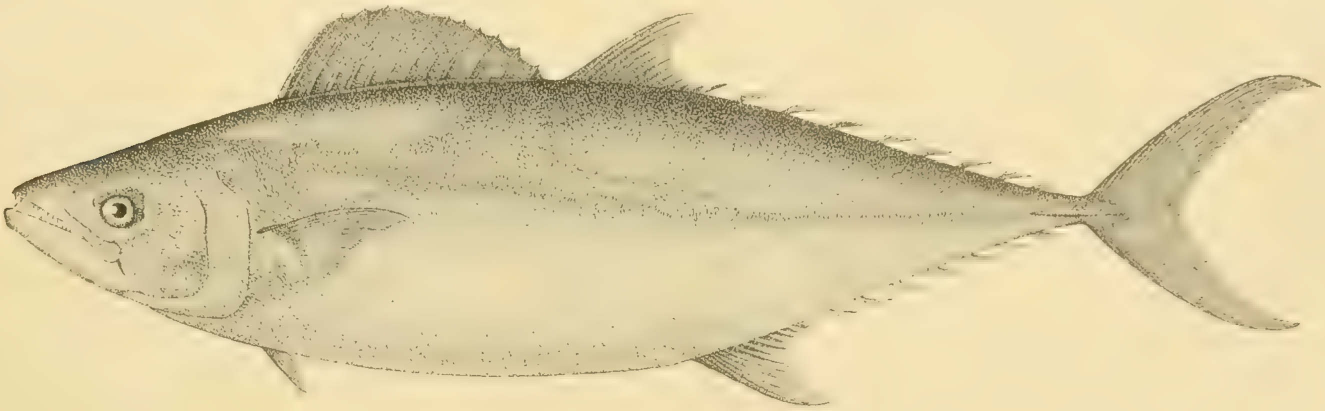

Fig. 29. Plain Pelamis (*Orcynopsis unicolor*), from Bohuslän. $^1/_4$ natural size.

R. br. 7; *D.* 13 $\frac{2}{11\text{ l. }12}$ VIII; *A.* $\frac{2}{11\text{ l. }12}$ VII; *P.* 2 l. 3 + 21; *V.* $^1/_5$; *C.* $x + 17 + x$.

Syn. *Scomber unicolor*, GEOFFR., *Descr. de l'Egypte*, *Poiss.*, tab. 24, fig. 6(?); GTHR (*Pelamys*), *Cat. Brit. Mus.*, *Fish.*, vol. II, p. 368; GILL (*Orcynopsis*), Proc. Acad. Nat. Sc., Philad., 1862, pp. 125 et 126; CEDERSTRÖM (*Pelamys*) Öfvers. Vet.-Akad. Förh. 1876, No. 4, p. 64; SUNDSTRÖM, *Fn. Sverg. Ryggr.*, p. 227; COLL, (*Orcynopsis*), Vid. Selsk. Forh. Christ. 1879, No. 15, p. 3; GIGL. (*Pelamichthys*), Espos. Int. Pesc. Berl. 1880, Cat. Sez. Ital., p. 85; LILLJ., (*Orcynopsis*), *Sv.*, *Norg. Fisk.*, vol. I, p. 266.

Cybium Bonaparti, VER., Att. 8:va Riun. Scienz. Ital. Genov. 1846, p. 493; FIL. et VER. (*Pelamys*), Mem. R. Accad. Sc. Tor., ser. 2, tom XVIII, p. 194, tab. fig. 4; MOR., *Hist. Nat. Poiss. Fr.*, vol. II, p. 434.

Thynnus peregrinus, COLL., Vid. Selsk. Forh. Christ. 1879, No. 1, p. 20, tab. 1, fig. 1.

Obs. Whether RÜPPEL'S *Thynnus* (*Pelamis*) *unicolor*[a] is identical with this species, as LÜTKEN[b] thought probable, cannot yet be decided. The difference in colour — the glossy, reddish violet of the belly, and the white tips of the second dorsal and the anal fins in RÜPPELL'S form — as well as the difference in the fin formula — one ray more or less in the first dorsal — is certainly unimportant when we consider the similarity in other respects. But the comparatively long ventral fins and the low anterior dorsal in RÜPPELL'S figure would form more important distinctions, if one could rely on these points when there is no mention of them in the description, and when they are possibly differences of sex or age. The great difference which we see in RÜPPELL'S figure between the length of the lower jaw and the base of the anal fin, which is considerably shorter, is also worthy of notice.

The Plain Pelamis, which attains a length of about 8 dm., is fairly elongated in form, like the following species, but more compressed than the true Tunny. The character, too, which is expressed in the small extent of the corslet, is common to both the species of *Pelamis;* but in the Plain Pelamis a belt of scales, starting from the corslet, runs along the whole of the lateral line, which is more even and less undulating in its course than in the Striped Pelamis. In comparison with the latter the hind part of the body is more elongated, the beginning of the second dorsal fin being situated in front of the middle of the body. The corslet is less marked than in the Tunny, but similar in form, with clearly defined sinuses at the beginning of the lateral line. The uppermost sinus extends forward along the side of the back to the gill-opening, and above it the scaly covering of the body follows the bases of both dorsal fins; the second sinus extends forward below the lateral line to the beginning of the first dorsal fin, and a third, smaller sinus, extending to a perpendicular from the middle of the pectoral fins, may be distinguished below this. The hind margin of the preoperculum is fairly straight, but the lower margin is arcuate. The hind margin of the gill-opening runs parallel to the margin of the preoperculum. The nostrils resemble those of the other Scombroids; the posterior being a perpendicular slit just in front of the eye, the anterior a round opening on a level with the upper margin of the eye and about half-way between the tip of the snout and the hind margin of the eye. The jaw teeth are subulate and large, but scattered. In the lower jaw, however, their height is greater than the distance between them, and about $^1/_2$ the diameter of the pupil. According to COLLETT, the palatine and vomerine teeth are small; and on the tongue there are two patches of villiform teeth.

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[a] *Neue Wirbelth.*, IV, (*Fische d. Rothen Meeres*), p. 40, tab. 12, fig. 1 = *Pelamys nuda*, GTHR., *Cat.*, l. c.; KLUNZ., Verh. Zool. Bot. Ges. Wien, 21 (1871), p. 443.

[b] *Spol. Atl.*, l. c., p. 477.

The internal organs of this species are little known, but in *Orcynopsis nuda*, which at least resembles it closely, KLUNZINGER (l. c.) found the pyloric appendages united into a gland, as CUVIER has stated is the case in the Tunny.

The Plain Pelamis is one of the rarest of fishes; and only a few specimens from the Mediterranean and three from the Cattegat and Christiania Fjord are known. Two of the latter were taken off Næsöen, between 6 and 7 miles from Christiania, at the end of August, 1876, and another was caught in the same year off Kongbäck in Strömstad Fjord and preserved by Dr. C. CEDERSTRÖM, by whom it was stuffed and sent to the Royal Museum.

Of its habits we only know that it follows the herring-shoals — COLLETT found the belly full of herring-fry — and as, in contrast to the other Scombroids, it is so seldom observed, it is highly probable that it generally keeps to deep or fairly deep water. FILIPPI and VERANY state that its flesh is good and wholesome. According to MOREAU, specimens from 7 to $7^1/_2$ dm. in length weigh 3 kgrm.

SUBGENUS **SARDA**.

Body behind the corslet covered with small scales. Height of the anal fin generally under 8 (fr. 5 to 7) % of the length of the body[a]. *Length of the ventral fins about equal to or greater than the height of the anal fin and at least $^2/_3$ (fr. 67 % to 74 %) of the length of the pectoral. Length of the head, as well as the distance between the tip of the snout and the first dorsal fin, at least $^1/_4$ (fr. 25 % to 27 %) of the length of the body. Length of the pectoral fins less than half (fr. 41 % to 43 %) the length of the head, of which the length of the ventral fins is more than $^1/_4$ (fr. 28 % to 31 %). Palatine bones with teeth, but the vomer toothless.*

It was CUVIER who first[b] introduced this subgenus, the name of which he afterwards[c] changed to *Pelamys*, while GILL[d] has adopted the older name, which among the Greeks, however, according to CUVIER, originally meant the salted flesh of the Tunny.

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[a] According to LÜTKEN, in the largest of the specimens of *Sarda chiliensis* examined by him the height of the anal fin was 9·8 % of the length of the body, and the length of the pectoral fins 55·5 % of the length of the head. This exception, as well as STEINDACHNER's statement as to the length of the ventral fins in the same species, indicates a condition of development which renders our generic and subgeneric definitions of the Scombroids merely expressions of more or less fixed stages in a common development. Strictly speaking, too, only the characters which we have adopted above (pp. 91 and 92) in the scheme for the division of the family, are constant; but the others show partly the different directions of development and partly the stages at which the forms, as far as we know them, have generally stopped.

[b] *Règn. Anim.*, éd. 2, vol. II, p. 199.

[c] CUV., VAL., l. c., pp. 138 and 149.

[d] Proc. Acad. Nat. Sc. Philad., 1862, p. 125.

THE STRIPE-BACKED PELAMIS.

SARDA PELAMIS.

Fig. 30.

Back bluish, with dark, transverse bands, which begin to disappear in adult specimens, or at least traces of them, and with oblique, longitudinal stripes, starting anteriorly low down and gradually rising till they reach the dorsal profile. Ventral side silvery or brass-coloured. Length of the lower jaw considerably greater than both the base of the anal fin and the length of the pectoral fins.

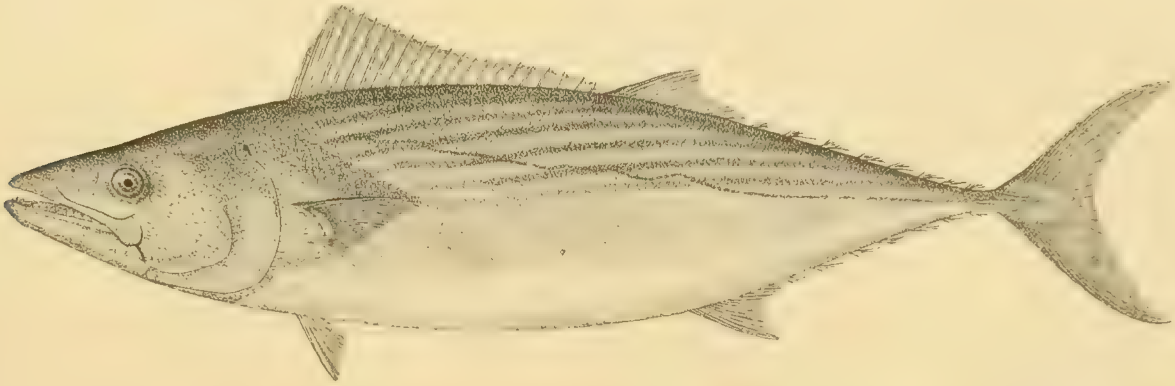

Fig. 30. Stripe-backed Pelamis from Strömstad Fjord. $^1/_3$ natural size.

R. br. 7; *D.* 22–24 $\frac{2-3}{12-14}$/VII—IX; *A.* $\frac{2-3}{11-13}$ VII–VIII; *P.* 2 + 24—26; *V.* $^1/_5$; *C.* x + 17 l. 18 + x.

Syn. *Scomber pelamis*, Brünn, *Ichth. Massil.*, p. 68 (nec. Lin.); Risso (*Thynnus*, ex specim. adult.), *Eur. Mér.*, vol. 3, p. 415; Gill (*Sarda pelamys*), Proc. Acad. Nat. Sc. Philad. 1862, p. 126: Lillj. (*Orcynus*), *Sc., Norg. Fisk.*, vol. I, p. 259.

Scomber sarda, p. p., Bloch, *Ausl. Fische*, part. VII, p. 44, tab. 334: Risso (*Thynnus*, ex specim. jun.), *Eur. Mér.*, vol. 3, p. 417; Cuv., Val., (*Pelamys*). *Hist. Nat. Poiss.*, vol. VIII, p. 149; *Règn. Anim. Illustr.*, *Poiss.*, tab. 48, fig. 2; Nordm., *Demid. Voy. Russ. Mér.*, p. 392; Gthr, *Cat. Brit. Mus.*, *Fish.*, vol. II, p. 367; Malm, Öfvers. Vet.-Akad. Förh. 1870, p. 837; Id., *Gbgs.*, *Boh. Fn.*, p. 418; Cederstr., Öfvers. Vet.-Akad. Förh. 1879, No. 2, p. 60; Coll., Vid. Selsk. Forh. Christ. 1879, No. 1, p. 19; Day, *Fish. G:t Brit.*, *Irel.*, vol. I, p. 102, tab. 38; Mor., *Hist. Nat. Poiss. Fr.*, vol. II, p. 430; Lillj. (*Orcynus*), l. c., p. 239.

Scomber mediterraneus, Bl., Schn., *Syst. Ichth.*, p. 23; Jord. et Gilb. (*Sarda*) *Syn. Fish. N. Amer.*, Bull. U. S. Nat. Mus., No. 16, p. 427.

Obs. It was Linnæus's mistaken use of the name *pelamis* for the Bonito, which had already been described by Osbeck under a binomial specific name (*Scomber pulcher*), that caused the blunder of which Brunnich was guilty, and the confusion which existed until Cuvier solved the question. The Bonito was not known to the old writers, while the Pelamis, even if the name was originally given to young Tunnies, was well described by Rondelet and received the name *pelamis* from Salvianus and that of *pelamys* from Willughby. It was also called *pelamide* by the Italians and in Marseilles. The disadvantages of having the same specific name within two genera so closely related to each other as *Orcynus* and *Sarda*, especially as the names of Bonito and Pelamis are often confounded, need no remark. But they are a natural consequence of the current laws of nomenclature, and can only be removed by the recognition, in defiance of these laws, of Bloch's specific name, *Sarda mediterranea*, as Jordan and Gilbert have proposed.

The Stripe-backed Pelamis, which attains a length of from 5 to 7 dm., is distinguished externally from the preceding species chiefly by the straight, or even slightly concave, upper margin of the first dorsal fin, but there is no anterior flap-like elevation of this fin in either species. The second dorsal and the anal fins, too, are lower, the pectoral shorter and the hind margin of the preoperculum, as well as of the whole gill-cover, more rounded, thus causing a resemblance, especially in the preoperculum, to the next genus and species. The head, too, is longer, the eye being completely situated in the front half of its length. The jaw-teeth are pointed, but somewhat compressed, and thus remind us of *Scomberomorus*. In the front of the lower jaw there are a few (from 2 to 4) large teeth which are almost distinct canines. The membrane on the margins of the preoperculum and operculum is finely ciliated, being fringed with small, short bristles, which are dentiform but soft, each of them externally seeming to form the extremity of a fine stria. Within the stria is a nerve-fibre, and the bristles thus serve as organs of touch. They are probably connected with the system of the lateral line. The corslet consists of larger scales than that of the preceding species; the scales of the body, indeed, seem throughout to have suffered less reduction, as distinct, though small, scales cover the hind part of the body as well. In the upper part of the axil of the pectoral fins we find one membranous flap, which is, however, fairly narrow, along the outside of the postclavicular bone, and another which runs down the inside of the fin. These flaps correspond to the membrane which in *Brama* extends throughout the inside of the pectoral fin and carries the peculiar scaly formations we have already noticed. The lateral line forms several undulating curves at its commencement, behind the head, and then advances beneath the second dorsal fin nearer the dorsal edge than in the preceding species. The dark, transverse bands on the back, easily recognisable as traces of a juvenile stage of development in the whole Mackerel-type, most often completely vanish with age, but may also be long retained. The oblique, but parallel, longitudinal streaks on the back are usually 7 in number, but may also be as many as 10. The superior ones are sometimes branched posteriorly.

A fuller comparison with the preceding species may be made by the help of the following table, which I have based partly on COLLETT's statements and partly on measurements of the specimens in the Royal Museum[a]:

	Average in 3 specimens of		Minimum in these 3 specimens of		Maximum in these 3 specimens of	
	Sarda unicolor.	*Sarda pelamis.*	*Sarda unicolor.*	*Sarda pelamis.*	*Sarda unicolor.*	*Sarda pelamis.*
Length of the body in millimetres	549	456	513	423	610	515
,, ,, ,, head ,, % of the length of the body	22.2	25.9	21.8(s)	24.9(s)	22.7(m)	27.4(m)
Diameter ,, ,, eye ,, ,, ,, ,, ,, ,, ,, head	13.6	13.6	13.3(j)	12.5(s)	14.0(s)	14.4(m)
,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, snout	37.7	40.5	35.7(j)	37.2(s)	40.0(s)	44.7(m)
Distance from the first dorsal fin to the tip of the snout in % of the length of the body	23.9	(26.9)	23.5(m)	(26.6 s)	24.5(j)	(27.1 j)
,, ,, ,, second ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,,	(48.3)	(57.4)		(55.8 s)	—	(59.1 j)
Height of the first dorsal in % of the length of the body	11.4(?)	(9.1)	(9.7 ? s)	(8.9 s)	12.6(j)	(9.3 j)
,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, head	51.3(?)	(35.0)	44.3 ?(s)	(54.0 j)	57.5(j)	(36.0 s)
,, ,, ,, second ,, ,, ,, ,, ,, ,, ,, ,, body	9.1	(7.0)	8.8(j)	(7.0 j)	9.8(s)	(7.1 s)
Length ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,,	12.1	(10.3)	11.8(m)	(9.1 s)	12.4(j)	(11.6 j)
Base ,, ,, anal ,, ,, ,, ,, ,, ,, ,, ,,	10.6	7.9	10.3(m)	7.7(j)	10.9(j)	8.1(s)
Height ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,,	9.7	6.3	9.5(m)	5.0(s)	9.8(s)	7.0(m)
Length ,, ,, pectoral ,, ,, ,, ,, ,, ,, ,, ,,	13.0	10.9	12.8(j)	10.6(j)	13.1(s)	11.4(m)
,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, head	58.5	42.1	57.1(m)	41.6(m)	60.1(s)	43.0(s)
,, ,, ,, ventral ,, ,, ,, ,, ,, ,, ,, body	(5.2)	(7.7)	—	7.7	—	7.7
,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, pectoral	41.0(?)	(70.3)	40.0(s)	(67.3 s)	42.0(j)	(73.3 j)
Distance from the ventral to the tip of the snout in % of the length of the body	(27.0)	(29.4)	—	(29.3 s)	—	(29.5 j)
Length of the ventral in % of the distance from them to the tip of the snout	(19.5)	(26.3)	—	(26.2 s)	—	(26.4 j)
Distance from the anal to the tip of the snout in % of the length of the body	(60.0)	(65.1)	—	(64.2 s)	—	(66.0 j)
Greatest depth of the body in % of the length	(22.6)	(22.0)	—	(21.7 j)	--	(22.3 s)
Length of the head in % of the distance from the first dorsal to the tip of the snout	92.8	(98.7)	90.0(j)	(93.9 j)	96.7(m)	(103.5 s)
,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, second ,, ,, ,, ,, ,, ,, ,,	(45.1)	(46.1)	—	(43.2 j)		(49.1 s)

The Stripe-backed Pelamis is a common fish in the Mediterranean, where, like the larger members of the family, it chases the Herrings, Sauries, and Garpike, often leaping out of the water after its prey. It is often taken in Sicily during the Tunny-fishery, and as an article of food is highly esteemed, whether fresh, salted, or preserved in oil. It seems to spawn off the English coast, too, for DAY states that fry 6 inches in length have been taken there. It is usually confounded with the Mackerel, however, and regarded only as a large specimen of that species. In Scandinavia only comparatively large specimens have been taken, and these but seldom. Only four such finds are known. The first, described by MALM, was caught on a Mackerel-line off Smögen (Bohuslän) on the 18th of July, 1863: two others were taken off Strömstad, in December, 1877, and January, 1878, during the Herring-fishery which had just begun, and are now preserved in the Royal Museum. The fourth was taken in a net near Christiania on the 15th of June, 1878. The species can thus be regarded only as an occasional visitor to the Scandinavian Fauna; but it is spread over the greater part of the Atlantic from the Cape of Good Hope to the North Sea and westward to the coast of Massachusetts. While DAY states that it has been observed that this species has latterly become rarer on the English coast, the case is said to be the opposite on the coast of America. It has sometimes been caught in enormous quantities, between Block Island and New York for example: the catch off Block Island alone in 1877 is said to have weighed at least 2 million lbs. At one haul of a purse-seine 1,500 specimens were taken[a]. In spite of this proof of its gregarious habits there, it seems that the Pelamis, as a rule at least, does not spawn on the coast of the Northern States, as only solitary young specimens have been found. As an article of food, the Pelamis ranks among the best of fishes in North America too, but the large quantity of blood it possesses and the high temperature of its body render it necessary to slaughter it soon after its capture, in order to prevent decomposition. In the Southern States instances are given of illnesses (diarrhœa, vomiting and skin-eruptions) due to the eating of the flesh of the Pelamis or of other closely related species.

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[a] In this table *j* denotes the smallest specimens, *s* the largest and *m* those of average size. The brackets indicate that the measurements in question have been made on only two specimens, or even one.

GENUS **AUXIS.**

Body fusiform, fairly high in adult specimens. The scales of the body form a distinct corslet in the preabdominal region, but behind this the body is naked (without scales). Dorsal fins far apart, the first triangular, the second of the same form as the anal, but either altogether or for the greater part at least situated in front of the latter. Finlets behind the dorsal and anal fins from 7 to 9. Pectoral fins set midway between the back and the belly. Eyes of average size: the adipose lid, as a rule, rudimentary. The preorbital bone covers at least a great part even of the back of the upper jaw-bone, when the mouth is closed. Jaw teeth small, set in a single row. Palatine bones and vomer without teeth. On each side of the end of the tail a middle carina and two shorter, lateral carinæ: behind the latter two weaker ones, which extend to the hind margin of the caudal fin. Pyloric appendages united into a glandulous mass, or (in youth?) free but repeatedly branched.

Of this genus, a remarkable intermediate form with some Thynnoid and some Scombroid (s. str.) characters highly developed, we probably know only one species, which was first described by COMMERSON as belonging to the neighbourhood of New Guinea.

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[a] See BROWN-GOODE. *Fish. Industr.*, pt. 1, p. 318.

THE FRIGATE-MACKEREL OR PLAIN BONITO.

AUXIS THAZARD.

Fig. 31.

Back glossy indigo or grayish blue, with irregular, dark-blue spots and stripes, which sometimes vanish: ventral sides silvery.

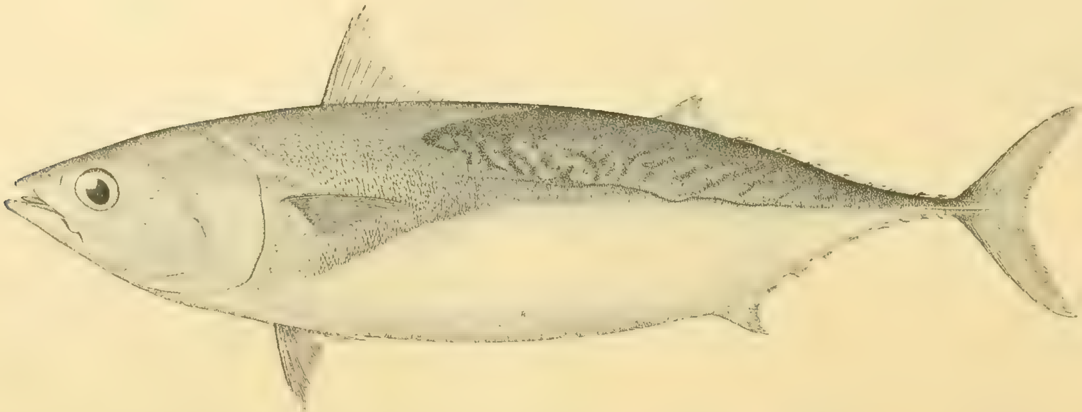

Fig. 31. Frigate-Mackerel (*Auxis thazard*), from the south of the Cattegat. Specimen belonging to Lund Museum. $^1/_3$ natural size.

R. br. 7; *D.* 10 l. 11 $\frac{2 \text{ l. } 3}{9 \text{ l. } 10}$/VIII l. IX; *A.* $\frac{2 \text{ l. } 3}{10 \text{ l. } 11}$/VII; *P.* 22 l. 23; *V.* $^1/_5$; *C.*[a] $x+19+x$.

Syn. *Scomber thazard*, LACEP., *Hist. Nat. Poiss.*, vol. III, p. 9; CUV., VAL. (*Auxis = Scomber tazo*, COMMERSON), *Hist. Nat. Poiss.*, vol. VIII, p. 146; BR.-GOODE (*Auxis*), *Fish. Industr. U. S.*, part. 1, p. 305, tab. 92.

Scomber Rochei, RISSO, *Ichth. Nice*, p. 165; ID. (*Thynnus rocheanus*), *Eur. Mér.*, vol. 3, p. 417; GTHR, (*Auxis*), *Cat. Brit. Mus., Fish.*, vol. II, p. 369; NILSS., Öfvers. Vet.-Akad. Förh. 1863, p. 500, tab. VI, DAY, *Fish. G:t Brit. Irel.*, part. I, p. 104, tab. XXXIX, fig. 1 et 1 *a*; LILLJ., *Sv., Norg. Fiskar*, vol. I, p. 280.

Scomber bisus, RAFIN., *Caratt.*, p. 45, tab. 2, fig. 1.

Auxis vulgaris, CUV., VAL., l. c., p. 139, tab. 211.

Orcynus thynnus, BR.-GOODE, *Fish. Industr.*, l. c., tab. 96.

Obs. Though CUVIER distinguished between COMMERSON's *Scomber taso* and the Frigate-Mackerel described by RISSO and RAFINESQUE, he personally acknowledged that he could discover no other difference than the absence in *taso* of the dark markings on the back, which he sometimes, however, could not find in the Frigate-Mackerel (l. c., p. 145), and a small, oval, blue-black spot under the eye, which, on the contrary, he assumed to mark *taso*. Both DAY and BROWN-GOODE, however, have amalgamated the two species; and, as we already know from GÜNTHER's explanation of BLEEKER's *Auxis thynnoides* as a synonym for *Auxis Rochei* that the Frigate-Mackerel has a place in the fauna of the East Indian Archipelago, there should be no doubt as to the meaning of LACÉPÈDE's *Scomber thazard*, a name which we must thus recognise as the original designation of the species.

The form of body of the Frigate-Mackerel changes so much with age that we have in it an admirable example of the transition from the Mackerel-type to that of the Tunny. During youth the greatest depth of the body is not more than $^1/_6$ of the length; but in old specimens it rises as high as $^1/_4$. With respect to the great distance between the two dorsal fins, which may be more than twice the length of the base of the first dorsal, the Frigate-Mackerel, as we have already stated, is really a Mackerel; but by the situation of the second dorsal fin, which lies either completely, or for the greater part, in front of the perpendicular from the beginning of the anal, it ranges itself with the Tunnies.

According to NILSSON's measurements the situations of these three fins are as follows:

Distance between the first dorsal and the tip of the snout in % of the length of the body, 32.8;

Distance between the second dorsal and the tip of the snout in % of the length of the body, 68.2;

Distance between the anal and the tip of the snout in % of the length of the body, 74.1.

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[a] $x+21+x$ according to MOREAU. $x+14+x$ according to LILLJEBORG.

[b] BLEEKER's *Auxis tapeinosoma* from Japan is also, according to STEINDACHNER (Denkschr. Math. Naturw. Cl. Akad. Wiss. Wien, Bd. XLIX, p. 180), identical with *Auxis Rochei*.

If we compare these measurements with the abovementioned figures of Day or Brown-Goode, which represent young specimens, we shall find that the corresponding proportions are, respectively, 29—30, 60 62, and 66—68. Hence we conclude that in the Frigate-Mackerel, as in the Mackerels, the length of the preabdominal region, as well as its height, increases with age, a state of things directly opposed to that we have observed above in the Tunnies, whose growth consists, to a great extent, in the elongation of the caudal region, and in which the dorsal and anal fins seem, in relation to the length of the body, to approach the tip of the snout as they grow older.

In the Frigate-Mackerel the form of the head is especially marked by the short, but pointed, snout and the sharply curved (almost elliptic) hind margin of the preoperculum. The length of the head about $^1/_4$ of that of the body. The eyes fairly small in proportion to the length of the head (between 19 and 17 %), but large in proportion to the length of the snout, of which they measure 75 %. Of the breadth of the interorbital space they measure 60 %. The gape comparatively small. When the mouth is closed, a great portion, even of the back part, of the upper jaw-bone is covered by the preorbital bone and its dermal flap; but the lower posterior corner and a part of the hind margin of the jaw-bone falls into a cavity in the external margin of the lower jaw. The margin of the gill-covers ciliated. The corslet well defined, with a depression, as usual, on each side for the pectoral fins and one common to the ventral fins. The uppermost of its points, which are directed backwards, extends to a point midway between the two dorsal fins, the middle ones, one on each side, follow the lateral line for some distance, and the lowest extends along the belly to a point somewhat behind the ventral fins. Of the sinuses, which are directed forwards, the upper extends to the end of the first dorsal fin or even as far as its 5th or 4th ray, and the lower to a perpendicular through the insertions of the pectoral and ventral fins. Behind the corslet the lateral line is undulating. The caudal carinæ are weaker than in the true Tunnies. The pectoral fins are fairly short, being a little longer than the ventral and somewhat less than $^1/_8$ of the length of the body. They do not extend quite so far back as the first dorsal. The first two rays in the first dorsal are the longest, the last two very short and the last of all generally so short that it scarcely projects above the margin of the fin-groove. The second dorsal and the anal fins are low and scaly.

The internal organs essentially correspond, according to Cuvier, to those of the Tunnies. The long tubular gall-bladder is especially remarkable. There is no air-bladder.

The colouring of the body, which on the whole resembles that of the Tunnina (*Euthynnus alliteratus*) is particularly subject to variations in the distinctness of the spots and of the dark, irregular, wavy transverse streaks on the back, which sometimes seem to have vanished entirely. The pectoral fins silver-gray on the outside and black on the inside. The other fins gray, the anal shading into yellow.

The Frigate-Mackerel is common in Japan, was seen in crowded shoals by Commerson off New Guinea and has long been known as a common fish in the Mediterranean. Like the Pelamis, it has latterly appeared in huge masses of the east coast of North America, where it has, however, been regarded up to now as an unwelcome intruder, its flesh being less esteemed than that of the other members of the family as it rapidly turns black on exposure to the air. "Its oil does not seem to be very abundant, and it will hardly pay at present to capture it solely for the purpose of using its flesh in the manufacture of fertilizers," says Brown-Goode. It is equally despised, according to Risso, in the Mediterranean. When salted, however, it is said to be eatable. According to Risso its weight seldom exceeds 3 kgrm. Its greatest length is apparently about 45 cm. The spawning-season is supposed to be in August, when the female deposits her eggs, which are whitish and enveloped in a reddish mucus.

The Frigate-Mackerel has been met with once or twice off the English coast and on one, single occasion in Scandinavian waters, at the fishing-village of Arild (Scania), where Baron Gyllenstjerna obtained a specimen 377 mm. in length, which was described by Nilsson and is now preserved in the Zoological Museum of Lund University.

GENUS SCOMBER.

Body an elongated fusiform or shorter and somewhat compressed (perciform). Scales of fairly uniform size distributed over the body, in the preabdominal region only slightly, but generally distinctly, larger than on the hind parts. Dorsal fins quite distinct, often far apart; the first more or less triangular, the second set almost vertically above the anal fin and corresponding to it in other respects too. Finlets behind the dorsal and anal fins usually 5, sometimes 4 or 6. In front of the anal fin one free, spinous ray. Pectoral fins set fairly high, at least the upper part of their insertion on a level with the pupil. Eyes comparatively large, but covered anteriorly and posteriorly by a well-developed adipose lid. Preorbital bone broad, completely covering the upper jaw-bone, when the mouth is closed. Small teeth, which are sometimes scarcely distinguishable and sometimes disappear, on the jaws, the head of the vomer and the palatine bones. On each side of the end of the tail, at the base of the caudal fin two lateral carinæ converging posteriorly and covered by a row of pointed dermal flaps, between which oblong, linguiform scales are set. No middle carina on the tail. Numerous, but free, pyloric appendages.

Most of the species belonging to this genus may easily be distinguished at the first glance from the other numbers of the family by the distinct scales of fairly equal size on the body, in conjunction with the wide separation of the dorsal fins. In the latter respect these Mackerels resemble only the preceding genus. But the genus *Scomber* also contains forms, e. g. *Scomber kanagurta* from the Red Sea and the Indian Ocean, in which the dorsal fins are nearer each other, or at least the groove of the first dorsal extends so far back as to reduce the distance between it and the second dorsal to about $^1/_5$ of the length of the first dorsal, thus depriving this distance of its value as a generic character. In this capacity the high development of the preorbital bone, the comparatively large size of the eyes and the unimportance of the difference in the size of the scales on the pectoral region and the hind parts of the body, are far safer guides. From the large size of the eyes and the comparatively small number of the finlets we may conclude that the genus *Scomber* occupies a lower rank in the scale of development of the family than the preceding genera.

Of this genus, according to GÜNTHER[a], no more than 7 species are known[b]. Only one of them belongs to the Scandinavian fauna.

THE MACKEREL.

SCOMBER SCOMBRUS.

Plate V, fig. 2.

Back bluish green with a dash of brassy yellow and wavy, black, transverse bands; below the limit of the dorsal colouring we often find a longitudinal row of dark spots, sometimes coalescent. Length of the suture between the suboperculum and interoperculum more than half of that between the former and the operculum. Scales on the hind parts of the body extremely small, much more so than in the region of the pectoral fins. No air-bladder.

R. br. 7; *D.* 10–12 $\frac{2-3}{8-10}$ V. l. VI; *A.* 1 $\frac{1\ -2}{8\ \ \ 11}$/IV l. V;

P. 1 l. 2+17–19; *V.* $\frac{1}{5}$; *C.* x+15 l. 16+x.

Syn. *Scomber* No. 1, ART. *Gen.*, p. 30; *Syn.*, p. 48; *Spec.*, p. 68. *Scomber scombrus*, LIN., *Syst. Nat.*, ed. X, tom. I, p. 297; RETZ. *Fn. Suec. Lin.*, p. 339; ASCAN., *Icon. Rer. Nat.*, part. 1, p. 4, tab. III; CUV., VAL., *Hist. Nat. Poiss.*, vol. VIII, p. 6; NILSS., *Prodr. Ichth. Scand.*, p. 83; KRØY., *Danm. Fiske*, vol. I, p. 220; NORDM., *Demid. Voy. Russ. Mér.*, p. 391; WRIGHT, FRIES, EKSTR., *Skand. Fiskar*, ed. 1, p. 128, tab. 29; NILSS., *Skand. Fn. Fisk.*, p. 129; LILLJ., Ups. Univ. Inbjudn. 4 Nov. 1864, p. 7; LINDSTRÖM, Gottl. Läns Hush.-Sällsk. Årsber. 1866, p. 25 (sep.); MALMGR., Öfvers. Vet.-Akad. Förh. 1867, No. 25, p. 260; ESMARCK, Forh. Naturf.

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[a] *Introd. Study Fish.*, p. 457; *Handb. Ichthyol.*, p. 323.

[b] According to STEINDACHNER's opinion that *Scomber pneumatophorus* and *Sc. colias* belong to the same species, the number of species known within the genus is reduced to 6.

Möde, Christ., 1868, p. 520; Malm, *Gbgs, Boh. Fn.*, p. 408; Lillj., *Sv.*, *Norg. Fiskar*, vol. I, p. 224; Jord., Gilb., *Syn. Fish. N. Amer.*, Bull. U. S. Nat. Mus., No. 16, p. 424; Br. Goode. *Fish. Industr. U. S.*, part. I, p. 281, tab. 91.
Scomber scomber, Lin., *Syst. Nat.*, ed. XII, tom. I, p. 492; Gthr, *Cat. Brit. Mus., Fish.*, vol. II, p. 357; Coll., Vid. Selsk. Forh. Christ. 1874, Tillægsh., p. 43; 1879, No. 1, p. 18; Winther, Naturh. Tidskr. Kbhvn, ser. 3, vol. XII, p. 12; Id., *Zool. Dan.*, *Fiske*, p. 21, tab. IV, fig. 3; Day, *Fish. G:t Brit., Irel.*, vol. I, p. 83, tab. XXXII et XXXIII (*var. punctatus*): Möb., Hcke, *Fische d. Ostsee*, p. 38.

The form of the body is handsome, elongated, terete and shallow: it tapers almost equally at both ends. The greatest depth, which is generally situated at the end of the first dorsal fin, varies according to age and sex between 15 % and 20 % of the length. The greatest breadth, which is situated at the same point, is somewhat more than $^2/_3$ of the greatest depth. Both the back and the belly are broad and convex, but the dorsal line is almost straight from the occiput to the second dorsal fin, from which point it slopes down towards the caudal fin. The ventral line, on the other hand, runs fairly evenly in a slight curve from the point of the lower jaw to the base of the caudal fin. The head is cuneiform, triangularly pointed and middle-sized. During the first year and up to the spring of the second its length is somewhat over $^1/_4$ (between 27 % and 25 %) of the length of the body; it then sinks to about 23 %; but after the third year it apparently rises again to about 24 %. The perpendicular drawn from the occiput to the isthmus through the hind margin of the orbit is about half the length of the head, and the breadth of the latter, measured above the hind margin of the orbit, is equal to the distance between the tip of the snout and the anterior margin of the pupil. The breadth of the interorbital space at the middle of the eyes is on an average about 42 % of the length of the lower jaw up to the end of the first year, during the second year about 46 % and afterwards about 57 %. The snout elongated and pointed; the mouth of average size. The jaws are of equal length; when the mouth is open, the lower seems longer than the upper; but when the mouth is closed, it glides under the broad, flat preorbital bones. At the margin of the intermaxillaries is a simple row of fine, pointed teeth of equal size, which are sparsely set and somewhat recurved. A similar row of teeth also occurs at the margin of the lower jaw. The pharyngeals, too, are covered with long, setiform teeth, and there are about 44 long gill-rakers on the front of the first branchial arch. At the margin of each palatine bone is a row of very small teeth, and laterally at each end of the head of the vomer we find from 2 to 4 somewhat larger teeth. The tongue is small and smooth, with the point free. The eyes of average size and set high; the diameter of the orbit measures about $^1/_5$ of the length of the head. They are covered with a thin, transparent membrane, which, however, seems to grow thicker toward winter. This membrane — the so-called adipose lid, though there is no fat whatever in it (see above) — extends along the side of the head and envelops the eyeball, but always leaves uncovered a perpendicular slit above the pupil. The anterior flap is continued some way over the posterior at the lower margin of the eye. The anterior nostril is, as usual, a round hole, and lies half-way between the tip of the snout and the anterior margin of the pupil: the posterior, as is also generally the case in the *Scombridæ*, is a perpendicular slit, situated half-way between the anterior nostril and the anterior margin of the pupil. The apparatus of the gill-cover is made up of thin bones with smooth margins: the hind margin of the operculum is somewhat incised, its length (in the direction of the body) is about $^1/_5$ (from 20 to 22 %) of the length of the head: along the preoperculum it is elongated downwards, over the suboperculum, into a point. The breadth of the back part of the interoperculum varies between 13 % and 16 % of the length of the head. The rounded lower corner of the preoperculum is elongated posteriorly in a downward direction. The striation of the margin of the preoperculum which we have observed above in *Sarda pelamis*, is not quite absent in this species, but is far more indistinct. The gill-openings are large. The branchiostegal membrane, which is free (not fastened at the isthmus) is supported by 7 rays on each side, the last two of which lie close together under the gill-cover.

The body is covered with very small scales, which on the silvery belly can scarcely be distinguished with the naked eye; in the region of the pectoral fins and along the clavicular bones, the posterior boundary of the gill-openings, they are somewhat larger, but form no distinct corslet. The lateral line, which lies much nearer the back than the belly, begins at the upper margin of the gill-opening and extends in a sinuous line to the middle of the caudal fin. The vent is situated at the beginning of the last third of the length of the body, measured from the tip of the snout to the base of the caudal fin.

The first dorsal fin, all the rays of which are unbranched, is short, high and almost triangular, with the upper posterior margin concave. When depressed, it lies hidden in a deep groove in the back; the second ray is the longest and the last rays are very short. In a large specimen from the north of the Sound there are only 10 rays in this fin, and the last ray is so short that it scarcely reaches half-way up the fin-groove. The second dorsal fin, which begins above the vent, is lower than the first, concave at the upper margin, half as high as it is long and covered with scales at the base. The anal fin begins a little farther back than the second dorsal, but it has the same form and the same covering of scales. The finlets behind the dorsal and anal fins consist of one ray, which is branched repeatedly, and are generally bent sideways in opposite directions on the back and the lower caudal edge. Thus, if the former are bent to the right, the latter are generally bent to the left. The pectoral fins are obliquely pointed and set, as is usual in the family, in a depression, so that there is no unevenness at the base when the fins are folded and laid back. In the axil a dermal flap, which is folded or at least dentated at the margin, hangs down from the outside of the postclavicular bone. The ventral fins are inserted a little farther forward than the beginning of the first dorsal, and almost vertically below the beginning of the third fifth of the length of the pectoral fins. They are narrow and obliquely pointed, are set close together and, like the pectoral fins, when folded, lie in a depression which has a dermal fold at the sides. The caudal fin is deeply forked, with narrow lobes, which are widely spread and have rounded points: the number of the rays, which it is difficult to distinguish on account of the thickness of the fin-membrane, is about $8+16+8$. Though there is not the least external trace of a middle carina on the sides of the tail, we find a raised, bony ridge on the penultimate and the last caudal vertebræ.

The colouring is so brilliant and variable that it is difficult to describe. The back and the forehead are dark green, with crooked, black transverse bands, sometimes like fine streaks (var. *scriptus*) and sometimes broken up into spots (var. *punctatus*), which extend down the sides somewhat below the lateral line[a]; between these lines the colour is a bright bluish, shading into greenish yellow. At the end of the dark transverse bands a more or less distinct, straight, black streak, which is sometimes broken up into spots, runs along the sides. From this point downward the colouring becomes gold, silver and mother-of-pearl, shading into red and yellow, while the belly is white. The sides of the head silvery: the margin of the mouth, the snout, the tip of the lower jaw, the inside of the branchiostegal membrane and sometimes the articulations of the gill-cover black: the first dorsal fin a clear, transparent gray. The second dorsal and the dorsal finlets blackish gray. The pectoral fins black at the base, especially on the inside, and gray at the point. The ventral and anal fins and the inferior caudal edge with its finlets white. The caudal fin dark gray.

On examination of the internal organs we find that the long digestive canal consists of a wide œsophagus, running in a straight line with the stomach, which is pointed and extends to the region of the vent. Around the pylorus and duodenum are a large number of long, narrow pyloric appendages, which follow the intestine to its first bend, from which point its diameter varies very slightly, though it forms two more bends. On the interior of the stomach are a large number of longitudinal folds, joined by fine, transverse wrinkles. The liver, which is situated far forward and for the most part to the left side, consists of one, large, thick lobe, which has an elongated point at its extremity. It is pale red in colour. The gall-bladder, which is long and narrow, lies on the right of the digestive canal. The spleen is small, oblong and blackish brown. The kidneys, which are narrower behind than in front, are almost as long as the abdominal cavity. No air-bladder. Two ovaries, as long as the whole abdominal cavity. The eggs fairly small. The milt-sacs of the same form as the ovaries. MALM has described hermaphrodites of this species[b]. All the statements as to an external difference of sex in the Mackerel which have been made up to the present, have proved untrustworthy on closer examination.

The usual length of the Mackerel is between 3 and 4 dcm. Off the English coast[c], however, specimens have been found, though seldom, 470 mm. in length; and ARTEDI, as well as STRÖM, mentions specimens, the length of which was 594 mm. The species occurs along the whole west coast of Scandinavia, as far as the most northern parts of Norway[a], though it is rare north of 62°, and has an equally wide range in the west of the Atlantic[b]. It is in the Skager Rack and the north of the Cattegat, as far as the neighbourhood of Kongsbacka and Læssö, and off the south coast of Norway, that the Mackerel is most common in Scandinavian waters. As far south as the Bay of Laholm Mackerel-fry are sometimes found in great numbers. Off the fishing-village of Kullen in Scania it is only occasionally found, though some few shoals appear yearly in the south of the Cattegat or even force their way through the Sound and the Belts into the Baltic, where both Cederström and Lindström declare it is known to the fishermen of Gothland. It is said to occur even in the Gulf of Finland, and though it is usually rare in the Baltic, Möbius and Heincke state that in August, 1851, it was seen in large shoals and caught in thousands in Kiel Bay. Off the coasts of Ireland and England and the west coast of France the Mackerel-fishery is one of the most lucrative of all. It is most valuable in the English Channel, which may in all probability be regarded as the central point of the range of the Mackerel in the east of the Atlantic. Farther south, where the Mackerel is found as far as the Canary Islands, as well as in the Mediterranean and the Black Sea, it is, however, less highly esteemed. According to Andersson's theory, which, however, was overthrown by Bloch[c], the Mackerel, like the Herring, was supposed yearly to make distant journeys from its winter-quarters in the Arctic Ocean. A French admiral[d] was told by his sailors that at the beginning of spring, in the bays of Greenland, they had seen thousands of Mackerel standing with their heads bored into the mud; and he added that the Mackerel first caught were blind and were taken without difficulty in a net, but that afterwards they were compelled to use hooks to catch them, as they then shunned the nets. Greenland's first naturalist, Fabricius, however, knew nothing of the occurrence of the Mackerel there; nor did Faber or any of his successors meet with it in Iceland. Again, these annual journeys lose all appearance of truth when we know that the Mackerel is caught as early in the year in the Mediterranean as in the North. After the experience Ekström gained in Bohuslän, his opinion, too, was that these journeys did not extend farther than from the deep water where the Mackerel spends the winter, to the island-belt where it spawns. The same opinion was maintained by Hind on behalf of the Canadians, in the dispute between Canada and the United States as to the right of the latter to take part in the fisheries in Canadian waters. But in his attempts to prove that the Mackerel hibernates in a state of lethargy at the bottom of the sea — we have similar stories of the hibernation of the swallows at the bottom of the lakes — he was met by Baird and Brown-Goode[e] on the part of the United States. They proved that within its range on the east coast of North America the Mackerel first appears in spring in the south and is gradually taken in increasing numbers farther and farther north. This circumstance, however, does not fully enable us to decide whether it is due to annual migrations from the south to the north and later in the year in the opposite direction, or whether it is only in the latter part of spring that the Mackerel ascends from the deep water off the northern parts of the coast.

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[a] The colour of the back may sometimes be an unvaried black (COLLETT: N. Mag. Naturv. 1884, p. 58).

[b] Öfvers. Vet.-Akad. förh. 1876, No. 5, p. 71, tab. V.

[c] DAY, l. c., p. 91.

In spring, while the shoals are pressing into the island-belt, the Mackerel keeps to the surface, always chooses places where there is a current, and is most restless in stormy weather, always swimming against wind and tide. Thus it happens that in certain years it arrives or departs earlier or later, according to the state of the weather[f]. Its wanderings begin early. It has been seen in spring as early as the beginning of May, off the southernmost point of Norway (Lindesnäs), and a few days after it appears on the inside of the island-belt of Bohuslän, where it seeks the shallower inlets. These shoals, however, are comparatively small, and the large ones do not enter the island-belt before the beginning of June. When the latter arrive, they may be seen at a long distance, as they always keep to the surface and cause such a disturbance in the water that the spray drifts like snow or clouds of dust. Their presence, too, is often betrayed by the gulls and other seabirds which prey upon them. The fishermen state that at night the Mackerel emits a light which is visible at a long distance. This is the ordinary phosphorescence created by disturbed lower animals (for the most part small crustaceans and medusæ) in their rapid movements in the water.

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[a] Krøyer (l. c. p. 595), S. Lovén (Ekström, l. c.), Malmgren (l. c.), Esmarck (l. c.), Collett (l. c.).

[b] "The Mackerel then," says Brown-Goode (l. c., p. 282), "would appear to be a shore-loving fish, not addicted to wide wanderings in the ocean, and with range limited in the Western Atlantic between latitudes 35° and 56°, in the Eastern Atlantic between 36° and 71°."

[c] *Fische Deutschl.*, pt. 2, p. 90.

[d] Cuv., Val., l. c., p. 18.

[e] Rep. Commiss. Fish a. Fisher., 1877, pp. 56 etc. and *Fisher. a. Fisher., Industr., U. S.*, sect. I. p. 282.

[f] In the west of the Atlantic, according to Brown-Goode, the Mackerel approaches the surface when the temperature of the water is about 45° Fahr.

In addition to these annual migrations the Mackerel, like several other fishes, often makes irregular wanderings. Thus, for a period of about ten years it may be more plentiful in one part of the island-belt than in another[a].

The Mackerel passes the winter in very deep water and, it is generally supposed, where the bottom is of a loose nature. The fishermen believe that at this time of year the eye of the Mackerel is covered by a membrane which prevents it from seeing. This is, of course, false; but still the adipose lid increases in thickness and extent even in autumn[b], while it becomes thinner and smaller between spring and summer. It is seldom that a single Mackerel is found in the island-belt of Bohuslän at the end of November, for when the westerly storms commence, which is generally at the beginning of this month, it makes its way out into deep water. It is stated, however, that in England half-grown Mackerel have several times been taken in great numbers in the middle of winter, in December and January.

The movements of the Mackerel are incredibly quick and active. It darts forward with the speed of an arrow and leaps out of the water with no less rapidity. When drawn out of the water and taken into the boat, it beats a lively tattoo, as it were, on the bottom; but this does not last long, as it dies very soon.

The Mackerel is a voracious glutton and eats whatever comes in its way. Besides small fishes and fry, Ekström also found in its stomach fragments of crustaceans and mollusks. That it feeds on jelly-fishes, is certainly a fable, for if, as often happens, a piece of a jelly-fish sticks to the hook or the bait, it will not bite. On the other hand, it is highly probable that, as it has often been seen snapping at jelly-fishes, it does so, as Möbius and Heincke have assumed, in its attempts to catch the parasitic crustaceans (*Hyperia galba*), that live in the genitals and the other parts of the jelly-fish. As a retribution for its own voracity, the Mackerel is the victim of several large fishes of prey, which seem to prefer its flesh to other food. Slices of Mackerel, too, are one of the best baits for sea-fishing, even when meant for its own kind.

On the coast of Bohuslän the spawning-season of the Mackerel generally occurs, according to Ekström's observations, in June; but still one may find specimens with ripe roe until late in July[c], the month, according to Sars, during which the Mackerel spawns in Norway. "It spawns in the open sea, where the roe drifts about until fully developed. I have found floating roe in Koster Fjord, as well as 6 miles off Känsö, in the middle of July" (Malm[d]). The eggs are about 1 millimetre in diameter, and may be distinguished, according to Sars, by a large, clear oil-bubble in the upper pole. The fry grow quickly. According to Dunn's observations, given by Day[e], in August and September the young Mackerel are about 76 mm. in length, in November from 152 to 157 mm. and in the following June from 203 to 228 mm. In the 13 specimens which have been available for examination at the Royal Museum, the following changes due to age are especially noticeable (the respective averages are given for each length[f]):

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[a] This is still more clearly proved in the countries where there are statistics as to the changes in the Mackerel-fisheries during a long period. Thus Earll reports (Rep. Comm. Fish. a. Fisher. 1881, p. 217) that in 1804, in the United States, 8,079 barrels of Mackerel were salted in Massachusetts, in 1814 only 1,349. In 1831 the number had increased to 383,658, but it then sank so fast that from 1839 to 1845 the average annual quantity was 67,674 barrels. About 1860 the Mackerel again became common, and for eight years the average quantity of Mackerel annually salted in Massachusetts was 246,877 barrels. Again the Mackerel became rare, and in 1877 only 105,017 barrels were submitted to inspection. But then the catch once more increased. In 1880 the total quantity of Mackerel taken in Massachusetts was calculated to amount to $95^{1}/_{2}$ million lbs. or about 400,000 barrels. In the same year, in the six states of the Union which are engaged in this fishery, Mackerel were taken to a quantity of about 132 million lbs., with a first-hand value (as sold in the market) of $2^{1}/_{2}$ million dollars.

[b] Cf Baird, as quoted by Brown-Goode, *Fisher. a. Fisher.-Industr.*, sect. I, pp. 287 and 288.

[c] "Towards the end of July": Malm, *Gbgs, Boh. Fn.*, p. 409. This year (1887), on the 19th of July, both male and female Mackerel from Bohuslän were bought in Stockholm, which were not quite, but very nearly, ready to deposit their spawn.

[d] Cf. Sars, Indber. for 1865, p. 28; for 1875, p. 14.

[e] l. c., p. 89.

[f] The numbers in the table which are enclosed in parentheses are not the average ones. The marks < and > respectively denote the maximum or minimum among the specimens of the same age.

Length of the body expressed in millimetres	137–140	201	226	340–389	390–410	411–422
Least depth of the tail, in % of the length of the lower jaw. Aver.	18.3 (<19.1)			22.5 {>19.7 21.1}		25.2 (>24.9)
Length of the ventral fins, „ „ „ „ „ „ „ body „	10.5		9.8			9.1
Distance between the first dorsal fin and the tip of the snout, in % of the length of the body „	35.0 (>33.3)		32.0 (<33.3)		32.3 (<33.3)	
„ „ „ second „ „ „ „ „ „ „ „ „ „ „ „ „ „ „ „	61.7 (<63.0)		64.5 (>63.6)		65.4 (>63.6)	
„ „ „ beginnings of the two dorsal fins „ „ „ „ „ „ „ „ „ „	26.7 (<27.2)		32.0 {>31.0 <32.8}		33.1 (>32.8)	
Length of the lower jaw in % of the length of the body „	11.8 (<14.5)		13.9		12.6 (<13.3)	
Breadth „ „ interorbital space „ „ „ „ „ „ „ lower jaw „	42.2 (<42.6)		46.4 {>44.6 <49.0}		56.8 (>51.9)	
Length „ „ head „ „ „ „ „ „ „ body „	26.9 (>26.5)	(25.3)	(24.3)	23.5	23.8	
„ „ „ pectoral fins „ „ „ „ „ „ „ „ „	11.4	(12.6)	(10.6?)		11.4	
Distance between the ventral and anal fins in % of the length of the body „		31.7	(34.9)		37.5 (>35.4)	
Distance between the anal fin and the tip of the snout „ „ „ „ „ „ „ „ „	62.6 (<63.4)				65.8 (>64.5)	

We thus see that the changes due to age are most marked between the first autumn and the following spring, and between the latter and the period immediately following. Some further changes appear most distinctly, when the length is about 390 mm., and others when it is about 410 mm., but it is an open question how far these latter changes belong to particular years. We have already explained the signification of the tendency of the changes indicated by the table. The Mackerel becomes capable of propagating its species when about 300 mm. in length.

The Mackerel is prepared for use in many different ways: it is eaten fresh or boiled in sea-water, salted or preserved in oil, smoked or dried. In whatever way prepared, it is always delicious, so long as it is not stale; and in flavour it is not much unlike the Salmon. Those taken in spring, are always lean; but the longer it has been in the island-belt, the fatter it grows, and it is fattest in October.

The Mackerel-fishery, which forms an important part of the fisheries in the western island-belt of Sweden, gives occupation to a great part of the population, and the profits are often by no means inconsiderable. First in spring, at the end of May, and then in autumn, during August, September, and October, the Mackerel is taken in seines along the coast, within the island-belt. During June and July, twenty years ago, in the open sea, it was caught mostly by whiffing or railing, a method not much employed now, except as sport, and replaced chiefly by drift-nets. The season for whiffing was always eagerly awaited in the island-belt. It began about a fortnight before midsummer and ended about St. Lawrence's Day (the 10th of August). Shortly before this period, the same activity and excitement might always be observed among the fishermen as at the approach of a general holiday. All the boats which were intended for the fishing, were now repaired, and each one strove to have the finest sails and the fastest boat. When the time came, they sailed out with set sails and before a fresh breeze. The line, which was furnished with a heavy plummet (1 or 2 lbs. in weight) and two hooks baited with some bright object, if possible a piece of the shining skin from the side of a Mackerel, was trailed after the boat at as rapid a speed as could be obtained. One boat with from 5 to 8 men and boys, each with two lines, sometimes took from one to three thousand Mackerel in a day; but the catch was generally much less, and it has been much better since the sixties, when the drift-net came into more general use. The drift-net is shot in the evening and dragged after the boat all night. The sails are taken in and the boat drifts with wind and current. The drift-net is most useful on dark nights, and it is said that the largest catches are made at nightfall and just before dawn. In 1878, according to the report of Mr. v. YHLEN, Inspector of Fisheries[a], there were 373 mackerel-boats in Bohuslän, with a total tonnage of 3,480 tons, with 10,450 nets and manned by 1,456 hands: the total catch for the year was 1,346,000 Mackerel. Up to that time, however, the most sucessful year had been 1873, when 1,813,000 Mackerel were taken in this manner in Bohuslän. In August and September the Mackerel may also be taken with the *sladörj*, a line furnished with a lighter sinker and cast from a boat which is at anchor; but though the depth chosen for this method of fishing is from 20 to 30 fathoms, the Mackerel are to be found only in mid-water, i. e. at a depth of from 10 to 12 fathoms. The fisherman chooses a different depth of water according to the season: as the season advances, the Mackerel gradually goes into deeper water, a fairly sure sign that it is on its way back to the deep sea.

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[a] Intern. Fisch. Ausstell. Berlin 1880, Schwed. Cat., I, 2, p. 45. In Bohuslän in 1890, according to A. H. MALM, 567 boats and 5 seines took about 2½ million Mackerel of a value of £26,121.

On the west coast of Norway, according to H. BAARS (*Die Fischereiindustrie Norwegens*, Bergen 1873, p. 58), about 2,500 boats are engaged in this fishery, and the annual catch is from 30 to 35 million Mackerel. The Mackerel-fishery is carried on on a still larger scale off the east coast of North America (see note *a*, p. 114), where the tackle employed consists chiefly of purse-seines[a]. (EKSTRÖM, SMITT.)

FAM. XIPHIIDÆ.

Body fusiform and elongated. Eyes middle-sized. Both the preoperculum and the supraorbital margins dentated during youth[b]*, smooth (like the other bones of the head) in full-grown specimens. The scales vanish during growth, in young specimens they are ciliated and some of them platelike and spinous. During youth one continuous fin on the back and in the anal region, but in full-grown specimens a greater or less part of the middle of these fins disappears, and thus two dorsal and two anal fins are formed, the anterior being, in both cases, larger than the posterior. No free spinous ray in front of the anal fin. Simple, pointed conical teeth in both jaws during youth; but they finally disappear in quite full-grown specimens*[c]*. During youth both jaws are more or less elongated in a forward direction, the upper more than the lower, but in full-grown specimens the lower jaw is still more considerably shorter than the upper, which is prolonged into a "sword," formed by the maxillary and intermaxillary bones, the vomer (rostral part) and the ethmoid bone. The superior longitudinal ridges on the skull are only slightly or not at all developed. In the species where there are ventral fins, they are thoracic, and the number of rays is less than usual, in other cases they are wanting. Gill-openings large, but the branchiostegal membranes partly united. Branchiostegal rays 7. Branched rays in the caudal fin at least 15. Vertebræ at least 24, more than 10 of them abdominal.*

AGASSIZ[d] separated this family from the Cuvierian Scombroids "in order more clearly to fix the characters of the latter;" but it is not without reason that both LÜTKEN[e] and LILLJEBORG[f] have suggested the reunion of these two families. It is not only that at least one genus of the Scombroids (*Acanthocybium*) has the same retiform branchial lamellæ as the Swordfishes (see above), nor that in the latter this coalescent formation of the branchial lamellæ does not appear during youth[g], but also that the osteological characters, to which AGASSIZ gave the first place in his diagnosis of the Swordfishes, to a great extent correspond to those of the Mackerels. The remarkable structure in the Swordfishes of the hæmapophyses of the caudal vertebræ, which consist of broad processes beneath the lateral holes of the hæmal canal and the consequent articulation between the hæmal arches of the successive vertebræ, apparently corresponds to the structure of the caudal vertebræ which we have remarked above in *Euthynnus*. The strong connecting-links in the Swordfishes between the interspinal bones and also between the interhæmal, which are formed by the sagittal extensions of these bones, and side by side with which the neural and the hæmal spines are also extraordinarily broad (extended in the same direction, the longitudinal direction of the body), are indeed wanting in the Mackerels; but still they are caused only by a stronger ossification of the membrane between these bones, which even in the Mackerels is sometimes fairly hard. The family character of the Swordfishes is thus the ensiform (sometimes cuneiform and terete) elongation of the snout, the chief part of which is composed of the rostral portion (originally the point of the *trabeculæ*) and the ethmoid bone which lies behind and within the rostral portion, while the point and the lateral edges of the sword are formed by the intermaxillary bones. The other differences between the Swordfishes and the Scombroids are the round shape of both nostrils and the greater distance between the posterior nostril and the eye in the former — in which respect the *Xiphiidæ* come nearer the Horse-Mackerels — the smaller size of the suboperculum and interoperculum — the operculum, however, is larger in the Swordfishes — and the smooth, or only slightly rugose, anterior edges of the branchial arches, where strongly developed gill-rakers appear in the Mackerels. The greatest systematic importance of the family *Xiphiidæ* consists in the changes due to age which have been given by GÜNTHER[a] and LÜTKEN[b] and partly even by CUVIER[c], and which we have therefore given in the above diagnosis of the family. First we see the larval stage (fig. 32), with the large eyes; the low, continuous dorsal fin and the similar, but smaller, anal fin; the rounded caudal fin; the broad and short pectoral fins, which are still set fairly high; and the spinous equipment of the head, which reminds us of the Trigloid type or the juvenile forms of the *Berycidæ*[d]. When the snout and the lower jaw (the length of which, however, is soon reduced again) begin to grow elongated, and the spinous equipment of the head to vanish, there appear other traits of older piscine forms, several scaly formations on the body (fig. 33), rows of spinous plates and scales, one on each side of the bases of the dorsal and anal fins and others, parallel to each other, on the sides, while in the intervals between these rows we find small scales, which also cover the head and snout, also spinous or ciliated. These scaly formations are not imbricate, but juxtaposed. During this period there are also fairly strong jaw-teeth; the unpaired fins appear as before; the body is long and slender; the caudal fin becomes more and more concave and is also prolonged and pointed like the pectoral fins; and the ventral fins, in those species where they are found, appear in the form of small protuberances, which become elongated and develop one or three rays, sometimes longer than those of the pectoral fins. We may also see before long, on each side of the tail, the middle carina (in *Xiphias*) or the two small carinæ (in *Tetrapturus* and *Histiophorus*), to which we have above seen corresponding formations in the Scombroids. The subsequent changes are mostly reductions: the disappearance of the scaly formations, the more or less complete disappearance of the jaw-teeth), the reduction of the middle part of the dorsal and anal fins, the relative diminution of the eyes and, lastly, the removal of the pectoral fins down towards the ventral edge, "so far,' says CUVIER of *Xiphias*, "that at the first glance one might be tempted to regard them as the ventral fins." In all these changes the Swordfish proper advances furthest: its relations to the other two genera of the family (each containing two or three species) form a distinct chain of development, *Histiophorus* having three rays in the ventral fins, *Tetrapturus* two and *Xiphias* having no ventral fins at all.

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[a] See also *Materials for a History of the Mackerel Fishery* by G. BROWN-GOODE, J. W. COLLINS, R. E. EARLL, and A H. CLARK, Rep. Comm. Fish. a. Fisher. 1881 (Washington 1884) pp. 91—531.

[b] In some species the corners of the temples (according to GÜNTHER, the parietal bones) and of the preoperculum are prolonged into strong spines, which call to mind the Trigloid type.

[c] In a Swordfish which has attained a length of 8 feet we find small, but numerous, teeth on the hind part of the intermaxillary bones.

[d] *Rech. Poiss. Foss.*, tome V, part. 1, pp. 1, 7 and 89.

[e] LÜTKEN, *Spol. Atl.*, Vid. Selsk. Skr., Kbhvn., 5:te Række, Naturv. Math. Afd., vol. XII, p. 447.

[f] *Sv. Norg. Fiskar*, vol. I, p. 379, not. 1.

[g] LÜTKEN, l. c., p. 446.

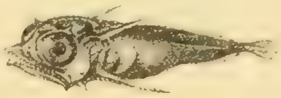

Fig. 32. Young specimen of a terete-snouted species of Swordfish (*Histiophorus?* or *Tetrapturus?*) from the South Atlantic. Magnified 7 diam. After LÜTKEN.

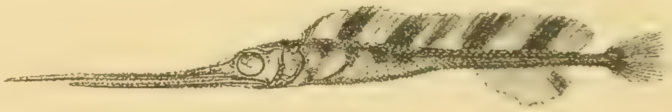

Fig. 33. Young Swordfish (*Xiphias gladius*) from the Atlantic. Magnified 2½ diam. After LÜTKEN.

This family, like the greater part of the preceding one, consists of distinctly pelagic fishes and powerful swimmers, which generally keep to the surface — those which retain the high dorsal fin are even said to use it as a sail — but are also able to descend to considerable depths. They really belong to the Tropics and the warmer parts of the Temperate Zones, but sometimes rove north into our latitudes.

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[a] Journ. Mus. Godeffr., Heft. 2, p. 170; Heft. 3, p. 265; *Introd. Study Fish.*, pp. 173–175: *Handb. Ichth.*, pp. 117 and 118.

[b] *Spol. Atl.*, l. c., pp. 441 etc., tab. II, fig. 10 and 11.

[c] CUV., VAL., *Hist. Nat. Poiss.*, vol. VIII, p. 261, tab. 225 et 226.

[d] According to LÜTKEN (l. c., p. 447), however, the long temporal and opercular spines are wanting in the larvæ of *Xiphias*.

GENUS XIPHIAS.

No ventral fins. In adult specimens the anterior part of the dorsal fin is pointed and falciform. The "sword" flat and two-edged. The middle caudal carina high: no small carinæ in adult specimens, though they may be distinguished during youth[a].

Only one species is known within this genus with its classical Greek name[b].

THE SWORDFISH.

XIPHIAS GLADIUS.

Plate IX, fig. 1.

Back lustrous dark-blue, sides grayish-blue, belly silvery.

R. br. 7; *D.* $\frac{3}{15(36)}\,3-4$; *A.* $\frac{2}{9(11)}\,3-5$; *P.* 2+14; *V.* 0; *C.* *x.*+15 l. 16+*x*.

Syn. Xiphias seu Gladius piscis, GESN., Hist. Anim. (Francof. 1620), Lib. IV, pp. 379 et 1049.

Xiphias, LIN., *Fn. Suec.*, ed. 1, p. 108.

Xiphias gladius, LIN., *Syst. Nat.*, ed. X, tom. I, p. 248; KÖLPIN, Vet.-Akad. Handl. 1770, p. 5; 1771, p. 115; RETS., *Fn. Suec. Lin.*, p. 316; CUV., VAL., *Hist. Nat. Poiss.*, vol. VIII, p. 255, tab. 225, 226, 231; NILLS. *Prodr. Ichth. Scand.*, p. 108; KRØY., *Danm. Fiske*, vol. I, p. 253; NORDM., *Demid. Voy. Russ. Mér.*, p. 393; EKSTR., Gbgs Vet., Vitt. Samh. Handl., Ny Tidsf., H. 1, p. 37; NILSS., *Skand. Fn.*, *Fisk.*, p. 147; GTHR, *Cat. Brit. Mus.*, *Fish.*, vol. II, p. 511; LINDSTR., *Gotl. Fiskar*, Gotl. Läns Hush. Sällsk. Årsber., 1866, p. 25 (sep.); WALLENGREN, Öfvers. Vet.-Akad. Förh. 1866, p. 5; COLL., Vid. Selsk. Forh. 1874, Tillægsh., p. 51; 1879, p. 33; CEDERSTRÖM, Öfvers. Vet.-Akad. Förh. 1876, No. 4, p. 64; MALM, *Gbgs*, *Boh. Fn.*, p. 423; WINTHER, Naturh. Tidskr. Kbhvn, ser. 3, vol. XII, p. 16; ID., *Zool. Dan.*, *Fiske*, p. 25, tab. IV, fig. 6; DAY, *Fish. G:t Brit.*, *Irel.*, vol. I, p. 146, tab. XLIX; MÖB., HCKE, *Fische d. Ostsee*, p. 36; BR.-GOODE, *Mater. Hist. Sword Fishes*, Wash. 1883; ID., *Fish. Industr. U. S.*, part. I, p. 336, tab. 115; COLL., N. Mag. f. Naturv. Christ., Bd. 29 (1884), p. 60; LILLJ., *Sv.*, *Norg. Fiskar*, vol. I, p. 380.

The fusiform body of the Swordfish is so elongated that in full-grown specimens the length is 6 times the depth; but the young specimens are still more elongated — at a length of 75 cm. the length of the body is nearly 8 times the greatest depth, and at a length of 37 mm. about 15 times[c]. In specimens 75 cm. long the greatest depth of the body is about $^1/_3$ of the distance from the point of the "sword" to the hind margin of the eye, in specimens half this size about $^1/_4$ and in specimens 37 mm. long only slightly over $^1/_6$. In adult specimens the greatest depth is about half-way along the high lobe of the first dorsal fin, behind the insertion of the pectoral fins. The length of the head, that of the sword included, varies in full-grown Swordfish between 40 and 45 % of the length of the body: in specimens 75 cm. long the head is almost as long as the trunk from the gill-opening to the base of the middle caudal rays. In young specimens, as we have mentioned, the lower jaw is comparatively much longer than in adult, and in specimens about 20 cm. in length[d] may be only slightly shorter than the upper jaw; in specimens 75 cm. in length the length of the head from the point of the lower jaw is about 26 % of the length of the body; and in adult specimens the length of this part of the head is about equal to the greatest depth of the body and about 16 % of the length. Even in adult specimens the length of the lower jaw varies considerably: in specimens from 2 to 4 metres long it varies between 15 and 11 % of the length of the body. The length of the snout from the anterior margin of the eye varies in full-grown specimens between 70 and 75 % of the length of the head; the diameter of the eye is about 6 % of the length of the head or somewhat less than half the breadth of the interorbital space. The eye is thus small in proportion to the length of the body and of the head, but in comparison with the width of the cheek it is large, and indicates, as WINTHER has remarked, that the Swordfish, sometimes at least, seeks its food in the deeper (darker) parts of the sea. Scarcely half the postorbital portion of the head is occupied by the cheeks (to the hind margin of the preoperculum), and the rest is formed by the operculum. In adult specimens the thickness (height) of the sword at its base is only $^1/_3$ of the breadth; but in young specimens the thickness rises as high as $^1/_2$ the breadth, and the form of the sword thus approaches its terete form in the other two genera, which in other respects, too, represent the juvenile stages of the family. On the side of the nose, on a level with the upper margin of the eye, lie the two round nostrils, the posterior being considerably larger than the anterior and the distance between it and the eye being about $^2/_3$ of the orbital diameter. The forehead is flat; the cheeks fall perpendicularly from it. The operculum is quadrilateral, almost square, thin and striated; its height is about 4 times that of the suboperculum, which is of nearly the same length, and the lower margin of which almost entirely forms the lower edge of the gill-cover, for the interoperculum is only a comparatively small triangle inserted between the suboperculum, the preoperculum and the lower jaw. The preoperculum, too, is remarkably short (in its horizontal branch) but of ordinary height. The forms of the dorsal, anal, and caudal fins and the changes due to age are given above. The apex of the dorsal fin is formed by the first branched rays and reaches a height which is but slightly less than the greatest depth of the body and is about equal to or even exceeds the length of the falciform pectoral fins. The lateral line is scarcely distinguishable, but it fairly closely follows the curve of the dorsal profile. The scales, like the jaw-teeth, as we mentioned above, almost completely disappear. No tongue or gill-rakers. The pyloric appendages are numerous, and are united into a mass like a bunch of grapes. The sclerotica of the eye contains two osseous laminæ, united by sutures, which in front (distally) leave a round opening for the cornea and behind an irregular hole for the optic nerve. The colouring of the body is a darker or lighter variation of the colours given above. In youth, like most Scombromorphi, the Swordfish is marked with dark transverse bands across the body.

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[a] LUTKEN, *Spol. Atl.*, l. c. p. 446.

[b] Ξιφίας, ARIST. etc., see ARTEDI, *Syn.*, p. 47.

[c] LÜTKEN, also mentions a specimen 19 cm. in length, where the greatest depth was only 10 mm.

[d] See DAY, *Fish. Gt. Brit.*, *Irel.*, plate XLIX, fig. 2.

From the classical times the history of the Swordfish has always been embellished with a thousand exaggerated tales of its fierceness and the hostility it entertains even towards objects which cannot serve as its food. It is really, however, of a peaceable disposition, and even remarkable for its timidity, but one of the most rapid swimmers of all fishes, and quite capable, though this is not its habit, of dealing other creatures dangerous wounds with its powerful sword. It has especially been accused as the bitterest enemy of the whale; but this may very easily be due to a confusion between the Swordfish and the Grampus (*Orca gladiator*). With regard to the terete-snouted Swordfishes it is an established fact that they have often darted at a vessel and pierced its side with their sword — in one case, even where the ship was copper-bottomed, to a depth of 14 in. Of such an action on the part of the true Swordfish, however, we have only one authenticated instance, which took place in Norway, where in August, 1839, it is said, a Swordfish 21 dcm. in length was caught at the mouth of a river far up Lerfjord in Helgeland, after having driven its sword into a boat[a]. We can set no great weight on the account given by YARRELL[b] of a Swordfish which killed a man bathing in the Severn, for the fish was probably rushing blindly forward in fright. From America we are told[c] that the Swordfish, when struck with a harpoon, turns upon the boat whence it has received the blow; but we may easily understand that on such provocation it is enraged to madness. Perhaps the real purpose of the sword is not yet fully known; but we must assume that it is connected with the procuring of food. BENNETT has given a clue to the explanation of the attacks made upon vessels by the terete-snouted Swordfishes. With lightning speed they dart among shoals of Bonitos, Albicores and other Scombroids, spitting them on their swords, intending afterwards to shake them off and devour them. When its victims seek shelter in the shadow of a ship, the Swordfish may miss its aim and strike the vessel's hull. Brown-Goode gives almost the same account of the true Swordfish[a]. "They feed on menhaden, mackerel, bonitoes, bluefish and other species which swim in close schools. Their habits of feeding have often been described to me by old fishermen. They are said to rise beneath the school of small fish, striking to the right and left with their swords until they have killed a number, which they then proceed to devour. Menhaden have been seen floating at the surface which have been cut nearly in twain by a blow of a sword. Mr. John H. Thomson remarks that he has seen them apparently throw the fish in the air, catching them as they fall.

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[a] Still it is worth mentioning that not a single word of the blow dealt to the boat occurs in the letter to KRØYER, wherein Governor CHRISTIE describes the catch. See *Danm. Fiske*, vol. I, Tillæg. p. 597. (Helgeland is a district of Finmark. Tr.).

[b] *Brit. Fish.*, ed. 2, vol. I, p. 165, after DANIELL, *Rural Sports*, 1801.

[c] BROWN-GOODE, *Mater. Hist. Sword-Fish.*, p. 45; *Fish. Industr. U. S.*, part. I, p. 351, from Prof. BAIRD'S notes.

"Capt. Benjamin Ashby says that they feed on mackerel, herring, whiting[b], and menhaden[c]. He has found half a bucketful of small fish of these kinds in the stomach of one Swordfish. He has seen them in the act of feeding. They rise perpendicularly out of the water until the sword and two-thirds of the remainder of the body are exposed to view. He has seen a school of herring crowding together at the surface on George's Banks as closely as they could be packed. A Swordfish came up through the dense mass and fell flat over on its side, striking many fish with the sides of its sword. He has at one time picked up as much as a bushel of herrings thus killed by a Swordfish on George's Banks." We know, too, that the Swordfish also feeds on the Cuttle-fish: Fleming found remains of *Loligo sagittata* in its stomach.

The peaceful disposition of the Swordfish may also be observed when together with the Tunny it enters the *madrague* or *tonnaro* of the Mediterranean fishermen. Sometimes it may tear the meshes of the lateral nets of the madrague with its sword and thus give the Tunnies a way of escape; but it is often taken together with them. It seems to be fairly sociable, and one often finds Swordfish roving in pairs (male and female?). The only information we have of the spawning-season is from the Mediterranean, where it is said to occur in spring and the beginning of summer; but we have no exact statements on this point. That it also spawns in the open sea, is shown by the finds of small fry, mentioned by Lütken, in the Atlantic and the Indian Ocean. In the Mediterranean young, but fully developed, Swordfish, weighing half-a-pound or more, are fairly common, and are often sold in the Italian fish-markets, especially in Sicily and at Genoa. Their flesh is more highly esteemed than that of the larger ones.

The Swordfish often attains a length of 12 feet or even more; but specimens of a much larger size must be considered at least as extraordinary exceptions, if not as altogether fabulous. Brown-Goode, however, mentions a specimen of uncommonly large size, which according to Ashby's measurements had a sword nearly 6 ft. long and should thus have had a body almost 18 feet in length and have weighed between 750 and 800 lbs. It is known in the Mediterranean, the Atlantic as far south as the Cape of Good Hope, the Indian Ocean, and the Pacific (off New Zealand). In the Atlantic it is fairly common off the coast of the United States of North America; but only full-grown specimens have been taken there: Captain Ashby is said to have caught 108 Swordfish in one year. On the European side it is not common even off the English coast, and farther north it occurs still more seldom, though it has been found in as high a latitude as West Finmark. However, it can scarcely be considered as being rare in Scandinavia, especially as it now and then enters the Baltic and wanders as far as Gothland[d]. Both Nilsson and Lilljeborg state, as a proof of its common occurrence off the south coast of Scania, that forty or fifty years ago, between Malmö and Skanör, one might very often see the dried tail of a Swordfish set up as a weathercock on a fisherman's cottage. According to Möbius and Heincke it is oftenest in autumn that it wanders into the Baltic, as far as the coasts of Prussia and Russia. Ekström and Malm have each described one of two specimens of the Swordfish taken recently in Bohuslän, the one in Åby Fjord and the other off Grebbestad: Cederström says that the Swordfish is fairly rare off the north of Bohuslän. Our figure is coloured from a female 211 cm. in length, which was caught on the 21st of October, 1887, in Stahrekil (5 miles from Strömstad), and sent to the Royal Museum by Mr. C. A. Hansson.

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[a] *Mater.* etc., p. 41; *Industr.* etc., p. 349.

[b] Not our European Whiting.

[c] A Swordfish 2·43 metres in length, which was caught on the 1st of October, 1882, in a mackerel-net in a bay between the coast of Schleswig and Alsen, had about 60 Herrings in its stomach (Möb., Hcke, l. c.).

[d] Lindström, l. c. and Lilljeborg, l. c., p. 388.

In Sweden the Swordfish is taken only occasionally, or it becomes stranded on a sandbank or a shelving beach, having ventured too near shore in search of food. But in the Mediterranean, especially off the coast of Sicily, and in North America, it is fished for with great vigour and no small profit, for its flesh is greatly valued. It is often harpooned from a boat or from a ship's bowsprit, where the Americans have a special place for the harpooner to stand. The Italians set watchmen on the cliffs to give the fishing-boats notice of the approach of the Swordfish, and in the boats they keep a look-out from the mast-head. As the Swordfish often swims at the surface, sometimes so high that the top of the dorsal fin projects above the water, it is easily caught sight of. The fishing has a dash of the charm of whaling, for it cannot be considered altogether free from danger, when the Swordfish at full speed takes out the line to the very end, and when we remember how many tales there are of the assaults it makes in selfdefence upon a boat. The Swordfish is also taken with hook and line, but, as in the mackerel-net and madrague, more seldom. Brown-Goode mentions the capture of a Swordfish on a long-line set for Halibut, at as great a depth as 275 fathoms.

Fam. LAMPRIDIDÆ.

Form of the body high, compressed, oval. Eyes of average size. External bones of the head with smooth edges[a]. *Scales small, thin, cycloid, and deciduous; in the pectoral region somewhat larger than in the other parts of the body. Spinous-rayed part of the dorsal and anal fins extremely short. No finlets. No free spinous ray in front of the anal fin. No jaw-teeth, but strong, pointed pharyngeal teeth. Jaws short and about equal in length. Supraoccipital crest high and continued forward over the frontal and ethmoid bones. Base of the pectoral fins horizontal. Ventral fins thoracic, though set fairly far back, with from 14 to 17 rays. Gill-openings large; branchiostegal membranes free at the isthmus. Branchiostegal rays 6* (*or 7?*). *Branched rays in the caudal fin about 17. Vertebræ from 43 to 48, the 22nd of which* (*taking the latter number*) *bears the last ribs.*

Gill[b] founded a separate family, *Lamprididæ*, within the group *Scombroidea*, to receive the single genus that represents this family, while Moreau[c] has given the same definition to a sub-family, *Lamprini*, within the family of the *Scombridæ*. These arrangements may be regarded as distinctions without a real difference.

The relation of this family to the preceding ones is expressed in several characters which indicate the highest stage of the metamorphosis which prevails among several Scombromorph families. Among these characters are the disappearance of the jaw-teeth, the horizontal base of the pointed, falciform, pectoral fins, which in form resemble the ventral fins and the anterior part of the dorsal fin, and the absence of the anterior, spinous-rayed dorsal. To these we may add another character, however, which is more indicative of a lower stage of development, namely, the large number of rays in the ventral fins, which are set comparatively far back. Their situation is indeed due to their close connexion with the shoulder-girdle, which is much developed posteriorly, and has thus removed the ventral fins with it. But the pelvic bones, though large, are hung, not, as is generally the case, on the clavicle, but on the high and broad coracoid bones. Another peculiarity of the pectoral fins is the anomalopterous character of their basal bones, the first three of which are low, and united with the scapular bones — the first of all completely, without the least visible suture; the other two retaining the suture — the last higher, but still broad, and closely united by a cartilage with the third basal bone and also with the coracoid bone. The glenoid surfaces of the first two basal bones are sharply convex, thus indicating unusual power in the perpendicular motions of the pectoral fins; the surface of the last two, on the other hand, is concave, to receive the cartilage which connects them with the posterior rays of the pectoral fins. Another peculiarity in the skeleton of the Opah which seems to indicate a lower (older) degree of development, appears in the structure of the last caudal vertebræ. The last of all, as usual, is without any true hæmal arch; but the three next to it have their hæmal arches free and not united to the bodies of the vertebræ, and the vertebra next in front of these has the hæmal arch united to its body, but retains the suture between them. The penultimate vertebra has both hæmapophyses widened at the base into a projecting ridge, which runs along the lower posterior part of the vertebra on each side, and is continued backward across the hypural bones, where it is free. We have above remarked a ridge corresponding to this in the common Mackerel, where it does indeed belong apparently to the hypural bones (the last caudal vertebra), though, there too, it originates distinctly on the side of the penultimate caudal vertebra. Even in the skeleton of the adult Mackerel and of the Scad, too, we may trace in the last caudal vertebræ (as far as the fourth from the end) sutures reminding us that the hæmapophyses were free in the earlier stages of development. Thus the skeleton of the Opah, even when the body is 11 dm. in length, explains a circumstance the elucidation of which in the Mackerels must probably be sought in the youngest specimens.

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[a] Juvenile stage unknown.

[b] *Arr. Fam. Fish.*, Smiths. Misc. Coll., No. 247, p. 9.

[c] *Hist. Nat. Poiss. Fr.*, tome 2, p. 483.

The family *Lampridideæ* thus possesses points of resemblance to all the preceding families in the long Mackerel-series — to the Bramoids in the high form of the body, to the Carangoids in the high supraoccipital crest, to the Scombroids in the large number of the vertebræ and to the Xiphioids in the reduction of the jaw-teeth and the circular form of the nostrils. But in this family we also find anomalopterous characters both in the situation of and in the number of rays in the ventral fins — the number of the rays calling to mind the position of *Beryx* in the Perch-series — as well as in the articulation of the pectoral fins. In the formation of the gill-covering apparatus it most nearly resembles the Carangoids, though the suboperculum is considerably smaller, and shaped like a triangular lamina, which occupies only a tiny part of the lower corner of the margin of the gill-opening.

As our knowledge of the changes of growth in the family is so imperfect — we only know that the tips of the dorsal and ventral fins become shorter with age[a] — and especially as the younger stages and the supposed larval stage are completely unknown, we have no data of sufficient importance to decide the correct place of the family. Its whole appearance, however, speaks in favour of its retention within the Mackerel-series, although the anomalopterous characters just mentioned may seem to assign it another place in the system.

Genus **LAMPRIS**[b],

the only genus within the family, contains only one known species,

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[a] Cuv., Val., *Hist. Nat. Poiss.*, vol. X, p. 58, tab. 282; cf. also Cuv. (Val.), *Règn. Anim. Illustré, Poiss.*, pl. 61.

[b] Retzius, Vet.-Akad. Handl. 1799, pt. 2, p. 91.

THE OPAH (SW. GLANSFISKEN).

LAMPRIS PELAGICUS.

Fig. 34.

Dorsal side dark steel-blue, on the sides gradually shading into green with a lustre of silver, purple and gold, the operculum being especially lustrous; the ventral side rose-red; the fins vermilion; the whole body strewn with silvery and milk-white spots; the iris golden red.

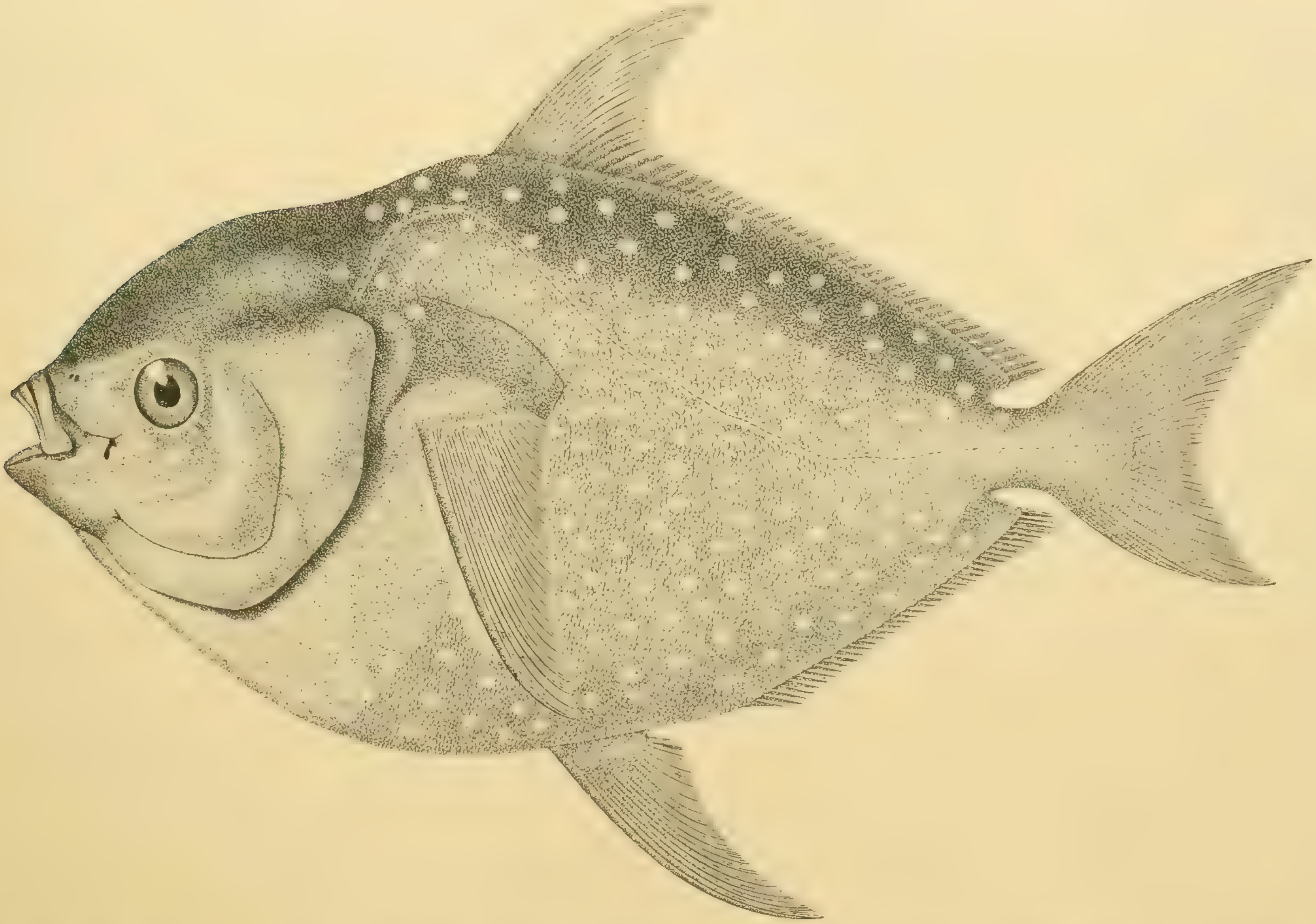

Fig. 34. Opah, from the W. coast of Zealand (Denmark). Specimen belonging to the Museum of Upsala Univ. $^{1}/_{6}$ the natural size.

R. br. 6 (7?); *D.*[a] $\frac{1(2)}{51}$; *A.*[b] $\frac{1}{40}$; *P.* 2 + 23(21) + 1; *V.* $\frac{1}{16}$; *C.* *x.* + 17 + *x.*

Syn. *Zeus cauda bifurca, colore argenteo purpureoque splendens*, STRÖM, *Söndm. Beskr.*, 1, p. 325, tab. 1, fig. 20.

Scomber pelagicus, GUNN., Norsk. Vid. Selsk. Skr. (Trondj.), part. IV (Kbhvn 1768), p. 92, tab. XII, fig. 1 (nec LIN.).

Poisson Lune, DUHAM., *Pêches*, Sect. III, p. 74, tab. XV: *Zeus luna*, GMEL., *Syst. Nat. Lin.*, I, p. 1225; LACEP. (*Chrysotosus*), *Hist. Nat. Poiss.*, vol. IV, p. 586; GTHR. (*Lampris*), *Cat. Brit. Mus., Fish.*, II, p. 416; MALM, *Gbgs. Boh. Fn.*, p. 420; DAY, *Fish. G:t Brit., Irel.*, vol. I, p. 118, tab. XLII.

Zeus guttatus, BRÜNN., D. Vid. Selsk. Skr., Ny Saml., part. 3, p. 398, tab. A; RETZ. (*Lampris*), Vet.-Akad. Handl. 1799,

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[a] *D.* $\frac{1}{52-54}$ according to LOWE.

[b] *A.* $\frac{1}{39-41}$ according to LOWE.

Qvart. 2, p. 98; Id., *Fn. Suec. Lin.*, p. 361; Faber (*Zeus*), *Fische Isl.*, p. 132; Nilss. (*Lampris*), *Prodr. Ichth. Scand.*, p. 70; Cuv., Val., l. c.; Kroy., *Danm. Fiske*, vol. I, p. 280; Ekstr., Gbgs Vet., Vitt. Samh. Handl. Ny Tidsf., I, p. 37; Lilljeb., Vet.-Akad. Handl. 1850, p. 333; Malm, Öfvers. Vet.-Akad. Förh. 1852, p. 229; Nilss., *Skand. Fn.*, *Fisk.*, p. 156; Esm., Forh. Skand. Naturf. Möde, Christ. 1868, p. 522; Coll., Vid. Selsk. Forh. Christ. 1874, Tillægsh., p. 48; 1879, p. 31; Winth., Naturh. Tidskr. Kbhvn, ser. 3, vol. XII, p. 15; Id., *Zool. Dan.*, *Fiske*, p. 21, tab. IV, fig. 2; Jord., Gilb., *Syn. Fish. N. Amer.*, Bull. U. S. Nat. Mus., No. 16, p. 453; Coll., N. Mag. f. Naturv. Christ., Bd 29 (1884), p. 59; Lilljeb., *Sv., Norg. Fisk.*, vol. I, p. 315.

Lampris lauta, Lowe, *Hist. Fish. Madeira*, p. 27, tab. V.

Obs. As the specific name employed by Gunnerus is the oldest binomial name of this species, according to the rules of custom it must be restored, though it is faulty in the same way as *Sarda pelamis*, the name recognised above, as in most modern writers, though Brunnich's use of it was also due to a mistaken determination of the species.

The specific character given above is a summary of a description which I have received in a letter from Mr. O. T. Olsen of Grimsby, of the coloration of a newly caught Opah which was brought to the above town in 1886. During life, or at least when uninjured and with the scales intact, however, the fish, according to Lowe's (l. c., p. 31) and Schneider's[a] descriptions, is red with a lustre of transparent silver thoughout the body: according to Schneider, too, the oval white spots do not occur in the living and uninjured fish, but first begin to appear when the scales drop off. Lowe, on the other hand, asserts that these spots appear more clearly and brightly through the scales, and describes the silvery lustre as being most distinct on the raised folds of skin which form the grooves for the dorsal and anal fins, and on the rows of scales which occur between the rays of the caudal fin. Anteriorly, on the belly, he says, the white spots are sometimes united into curved, vermiform streaks. Other writers do not insist so strongly upon the red colour of the body, at least on the dorsal side; and the only specimen which has been received by the Royal Museum, had lost most of its metallic lustre — even the white spots were extremely indistinct — and the upper half of the body was dark, almost velvety, blue-black. This specimen, which was caught in the Cattegat in August, 1873, was, however, half decomposed when it arrived here, and thus could scarcely give any idea of the colouring of the fish during life. It is highly probable that the colour varies and that the red is part of its fine dress during the spawning-season; but all descriptions agree in setting the Opah among the most showily-decked of fishes — "one of Neptune's courtiers in full dress," writes one of Buffon's correspondents who is quoted by Lacépède.

The body of the Opah seems to vary considerably in depth. Collett mentions[b] a specimen 109 cm. in length and 607 mm. in depth, i. e. the depth about 56 % of the length, and another specimen[c] 6 ft. in length and 2 ft. 4 in. in depth, i. e. the depth about 39 % of the length. To judge by these statements, in the older specimens the body becomes considerably elongated with age, while the height of the dorsal fin and the length of the ventral fins, according to Valenciennes' observation mentioned above, sink from more than $^1/_2$ the length of the body to $^1/_4$ or $^1/_5$ of the same. The thickness of the body, according to Lilljeborg, is about 30 % of its depth. The length of the head, according to Collett, varies between 30 % of the length of the body, in the smaller specimen mentioned above, and 24 %, in the larger one. The diameter of the eye, according to both Lowe and Lilljeborg, is about $^1/_5$ of the length of the head and about $^1/_2$ the breadth of the interorbital space. The small oval nostrils, which are close to each other, are set on a level with the upper margin of the eye and about half-way between the eye and the tip of the snout. The mouth is small in comparison with that of the Mackerels, but capable of some, though only slight, protrusion. The tongue is narrow, free and smooth, according to Lowe. In the skeleton the lingual bone is cartilaginous; but the basihyal bones are large and spongeous, the first pair being fairly long and sharply curved downwards — between their extremities is placed the huge, triangular, basibranchiostegal bone (Parker; *urohyal*, Owen), which hangs down in a posterior direction. The number of branchiostegal rays is 6; but we must not forget to remark that not only Gunnerus among the old writers, but also Valenciennes, Kroyer and Bakker[d], the last both in the text and the figure, have given 7. Though there are two simple rays at the beginning of the dorsal fin, the first is extremely short, and united to the base of the second, which in the specimen belonging to the Royal Museum is broken off short, but according to Lowe is the longest ray in the whole fin. A peculiar, falciform, interspinal bone, with the concave margin grooved, lies loose in the flesh between the occiput and the first dorsal fin[b]. The first true interspinal bone is both long and high, with the curved anterior margin dilated and with several pairs of lateral ridges, the posterior, in particular, high and sharp, but less so than on the eight next following interspinal bones. The interspinal bones are gradually reduced in length in the same proportion as the length of the rays in the dorsal fin from the first branched ray to the twelfth. The neural spines in the abdominal region, on the other hand, become longer posteriorly. The dorsal fin in form resembles that of the Swordfish: behind the elevated, falciform, anterior part follows a low portion, from the fourteenth ray to the seventeenth inclusive, in the specimen of the Royal Museum, and then the fin again rises, though slowly and inconsiderably. The anal fin throughout its length resembles the posterior part of the dorsal. The lateral line is sharply curved in an elevated arch anteriorly, and then runs straight along the body in the middle line of the depth.

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[a] See Collett, Christ. Vid. Selsk. Forh. 1879, No. 1, p. 32.

[b] N. Mag. Naturv. 1884, p. 60.

Christ. Vid. Selsk. Forh. 1874, Tillægsh. p. 49.

[d] *Osteographia Piscium*. Gröningen 1822, p. 187, tab. III, fig. III, *r*

The Opah is one of the deep-sea fishes of the Atlantic, known from Norwegian Finmark, Iceland and Newfoundland at least as far south as Teneriffe, and also occurs in the Mediterranean, but is generally very rare. In Madeira, however, according to Lowe, it is fairly often brought to market during spring. It cannot, however, be reckoned among the inhabitants of the deepest regions, as seaweeds are occasionally found with other food in its stomach. Its food consists chiefly of cuttlefish, thin-shelled Isopods which have their home in the algæ, Herrings and, probably, other small fishes. It is caught off Madeira, says Lowe, with hooks baited with Mackerel or Scad, at a depth of from 50 to 100 fathoms. This depth, if indeed it be the Opah's proper home, is great enough to prevent it from moving freely at its pleasure at the surface[c], when for some reason or other it suddenly rises into the higher regions of the ocean. Thus, like other deep-sea fishes, it is often found floating helplessly at the surface or cast ashore by the waves. It attains a length of about $4^{1}/_{2}$ feet ($1^{1}/_{2}$ metres)[d]; but most of the specimens known have measured between 3 and 4 ft. in length. Its whole body is very fat, and its flavour is compared by most of those who have tasted it, to that of the Salmon; but Mr. Olsen writes to me that a part of his Opah tasted like beef, another part like veal, a third like brain, and a fourth like "fish." In Madeira, says Lowe[e], the flesh of the Opah is considered better and costs more than that of the Tunny. "Formerly, I am informed, it was held in such esteem that every fish taken was obliged by law to be carried to the governor of the Island, without whose licence it could not be sold in the market."

In Norway the Opah is rare, but according to both Lilljeborg and Collett a specimen is taken almost every year in the neighbourhood of Bergen. So early a writer as Peder Claussen[f] knew it from Nordland and called it "*den sköne Laxestörje*" (the beautiful Great Salmon). It has been met with several times in Christiania Fjord and, strangely enough, off the coast of Zealand and near Helsingborg. It was from the last place that Retzius described it for the first time as a Swedish fish. We have fewer mentions of it from Bohuslän; but according to Malm it is known to a few of the fishermen by the name of "*makrilstörje*". Ekström (l. c.) mentions a specimen which was caught in the forties in the neighbourhood of Strömstad; and the specimen of the Royal Museum which we have already mentioned, was taken at the beginning of August, 1873, by some fishermen from

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[a] Cf. Lowe, l. c., p. 29.

[b] Cf. Lowe, l. c., p. 34.

[c] See above, under Genus *Caranx*.

[d] Baikie (Zool. 1853), according to Day (l. c.), mentions a specimen 6 ft. long, which was caught off Sanday, one of the Orkneys. The specimen mentioned above which was examined by Olsen, he states to have measured 5 ft. in length, 3 ft. in depth and 10 in. in thickness.

[e] l. c., p. 35.

[f] *Norriges Beskriffuelse*, Kjobenhaffn 1632, p. 120.

Fiskebäckskil, who exhibited it for several days to the visitors at Lysekil[a], where it was afterwards purchased and sent to the Royal Museum by Dr. A. STUXBERG.

According to FABER (l. c.) the Opah is mentioned in the Edda under the name of *Gudlax* (*godlax* = good Salmon)[b], and in Iceland every part of the fish is in general use as a remedy for all kinds of diseases.

The following Acanthopterygian Eleutherognates are distinguished from the preceding Lysipharyngii by several characters, which we have above endeavoured to express by the name of *Anomalopteri*.

The Scandinavian Fauna contains the following families belonging to this division:

A: Ventral fins independent, jugular. Spinous-rayed part of the dorsal fin or fins considerably shorter or with a smaller number of rays than the soft-rayed part. No anal papilla. Suborbital ring without any osseous connexion with the preoperculum: *Trachinomorphi.*
  1: Gill-openings in front of the pectoral fins.
    a: Body compressed .... Fam. *Trachinidæ.*
    b: Head broad and flattened .... „ *Batrachidæ.*
  2: Gill-openings behind or above the pectoral fins... ... . Fam. *Lophiidæ.*

B: Ventral fins independent, thoracic or jugular. Suborbital ring joined to the preoperculum by an osseous connexion. A prominent papilla often present at the vent. Body Cottiform or Perciform: *Cottomorphi.*
  1: Body with ordinary scales or naked or partly covered with plates.
    a: Spinous-rayed part of the dorsal fin longer (with more rays) than the soft-rayed part, or at least as long as it..... Fam. *Scorpænidæ.*
    b: Spinous-rayed part of the dorsal fin shorter (with fewer rays) than the soft-rayed part .... Fam. *Cottidæ.*
  2: Body almost entirely covered with plates Fam. *Agonidæ.*

C: Ventral fins (when present) independent, jugular or thoracic. A prominent papilla sometimes present at the vent. Spinous-rayed part of the dorsal fin (where it is hardened) longer (with more rays), or at least only slightly shorter, than the soft-rayed part behind the spinous rays. Suborbital ring usually without any osseous connexion with the preoperculum. Body low and compressed, more or less taenoid: *Blennomorphi.*
  1: No molars on the jaws or palate. Fam. *Blenniidæ.*
  2: Molars on the jaws and palate ... „ *Anarrhichadidæ.*

D: Ventral fins generally united. A prominent papilla at the vent. Spinous-rayed part of the dorsal fin shorter than the soft-rayed, and with flexible spines, or wanting. Suborbital ring generally without any osseous connexion with the preoperculum. Body long and low or bulky: *Gobiomorphi.*
  1: The rays of the ventral fins may be externally distinguished, but the fins are united in a funnel form .... Fam. *Gobiidæ.*
  2: Rays of the ventral fins distinguishable and the fins remote from each other. Fam. *Callionymidæ.*
  3: Rays of the ventral fins indistinguishable in the sucking-disk formed by the union of these fins..... .... Fam. *Cyclopteridæ.*
  4: Ventral fins remote from each other, but between them a sucking-disk. No spinous-rayed part in the dorsal fin. Fam. *Gobiesocidæ.*

E: Ventral fins independent, much longer than the pectoral, and generally with more than five soft rays. Form of the body high and compressed: *Cyttomorphi* .. .. Fam. *Zenidæ.*

F: Ventral fins (where they exist) independent, much longer than the pectoral, and generally with less or more than five soft rays. No anal fin. Body compressed and long, ribbon-shaped. Caudal fin irregular, raised upwards, or wanting: *Trachypteromorphi* Fam. *Trachypteridæ.*

G: Ventral fins independent, abdominal: *Mugiliformes* .... Fam. *Mugilidæ.*

We give the first place among these fishes to a group of families, as a type of which we may take the well-known and really formidable Weever.

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[a] A watering-place in Bohuslän. TR.

[b] AASEN (*Norsk Ordbog*) suspects, however, that by this word may be meant *Guldlax* (Gullax, *Argentina Silus*, according to NILSSON).

TRACHINOMORPHI.

First dorsal fin[a] shorter than the second. Pectoral fins with broad base and with broad and flattened or elongated basal bones. Ventral fins free and jugular. Branched rays in the caudal fin less than 15. No osseous connexion between the suborbital ring and the preoperculum. Jaws and palatine bones (as a rule) with teeth.

Between the Mackerels and the Cottoids GÜNTHER[b] has placed some families which do not belong in their entirety to this division[c], but apparently consist of a series of types which connects the most abnormal Anomalopterous forms with the *Labromorphi*, as well as with the *Percomorphi*. In the *Uranoscopi* the Trachinoid type comes near the *Batrachidæ*, and the latter in their turn form a transition to the Lophioid group; but within the family *Trachinidæ* itself — provided it be possible to retain it with GÜNTHER's definition — the genera *Percis* and *Pinguipes* clearly point to the *Labridæ* and also to the family *Malacanthidæ*[d], while the dental equipment of the palate led CUVIER to include the Weevers in the Percoid family, as "Perches with jugular ventral fins." The other fishes in the group resemble the *Cottidæ* or, in their compressed form, the *Blenniidæ*.

The members of this group are, as a rule, poor swimmers, and bottom-fishes, and for the most part live near shore, where they lie in ambush for their prey or entice it by the movements of their strange appendages. Most of them belong to the Southern Hemisphere, where in the Antarctic regions they take the place of the Cottoids in the Arctic fauna.

FAM. TRACHINIDÆ.

Body long and compressed. Head without armour[e]. Scales (where they exist) cycloid or granular. The eyes are set laterally, but high up, and admit of being turned upwards. Anal and second dorsal fins long in proportion to the length of the abdominal region. Basal bones of the pectoral fins broad and flat, but of ordinary shape. Jaw-teeth of uniform size, or with several canines interspersed in front. Lips without fringes. Lateral line unbroken. Gill-openings in front of the pectoral fins.

With this definition the family essentially corresponds to GÜNTHER's subfamily *Trachinini*, which was intended to include 14 genera, only one of which is represented in the Scandinavian fauna.

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[a] Or the spinous-rayed part, where the fin is continuous.

[b] *Systematic Synopsis*, l. c.

[c] GÜNTHER has himself remarked the resemblance between the genus *Sillago* (among his *Trachinidæ*) and the Sciænoids.

[d] Cf. CUV., VAL., *Hist. Nat. Poiss.*, vol. III, p. 277 and GÜNTHER, *Cat. Brit. Mus.*, *Fish.*, vol. III. p. 358.

[e] In old specimens of *Trachinus*, however, the top of the head (the forehead and occiput) is naked and rough, as in the *Uranoscopi*.

GENUS TRACHINUS.

Head slightly broader (thicker) than the trunk. Gape distinctly vertical. Cardiform teeth on the jaws, the vomer, the palatine and the pterygoid bones. Tongue smooth. A strong, pointed spine on the operculum. Preoperculum and preorbital bones dentated, but sometimes with the dentations hidden by the skin[a]. *Six or seven strong, pungent, spinous rays in the first dorsal fin. Lower rays of the pectoral fins undivided or at least with free tips. Scales of the body small, and arranged in distinct, oblique, transverse rows. Branchiostegal rays 6. Pseudobranchiæ distinct. Pyloric appendages few, usually 6. No air-bladder. Branched rays in the caudal fin 10 or 11.*

The genus *Trachinus*, in which five very closely related species are recorded[b], in its geographical range has the peculiarity that it is known only in the Mediterranean, the west coasts of Europe and Africa, and the west coast of S. America, while from the west of the Atlantic we have no information of a single species of the genus.

THE GREAT WEEVER (SW. FJÄRSINGEN).

TRACHINUS DRACO.

(Plate IV, fig. 3.)

Preorbital spine short, dentoid, turned downwards and outwards in a forward direction. Two or three supraorbital spines above the anterior upper corner of the orbit. First dorsal fin black, with 6 spinous rays; the second with about 30 rays, and the anal with about 32. Cheeks scaly. Greatest depth of the body from 15 to 19 % of the length.

$R.\ br.\ 6;\ D.\ 6^{c}/28\text{—}31^{d};\ A.\ \frac{2}{30\ \text{l.}\ 31^{e}};\ P.\ 1\ \text{l.}\ 2+8\ \text{ad}\ 10+6\ \text{l.}\ 5;\ V.\ ^{1}/_{5};\ C.\ x+11+x.$

Syn. *Δράκων*, ARISTOT. cett.: vide ART., *Ichth.*, *Syn.*, p. 70.
Trachinus draco, LIN., *Syst. Nat.*, ed. X, tom. I, p. 250; BRÜNN., *Ichth. Massil.*, p. 19; RISSO, *Ichth. Nice*, p. 108: ID., *Eur. Mér.*, vol. III, p. 260; CUV., VAL., *Hist. Nat. Poiss.*, vol. III, p. 238; NILSS., *Prodr. Ichth. Sc.*, p. 90; FRIES, EKSTR. et WRIGHT, *Skand. Fiskar*, ed. 1, p. 13, pl. 3, fig. 1; KRØY., *Danm. Fiske*, vol. I, p. 55; NORDM. in DEM., *Voy. Rus. Mér.*, vol. III, p. 370; COSTA, *Fn. Regn. Nap.*, part. 1, Acantotterigi Percoidei, Trachini, p. 1; NILSS., *Skand. Fn.*, *Fisk.*, p. 40; GTHR, *Cat. Brit. Mus.*, *Fish.*, vol. II, p. 233; STEIND., Stzber. Akad. Wiss. Wien, Math. Naturw. Cl., LVI (1867), 1, p. 696; COLL., Vid. Selsk. Forh. Christ., 1874, Tillægsh., p. 42; SCHMIDT, Nord. Medic. Ark. 1874, No. 2; MALM, *Gbgs*, *Boh. Fn.*, p. 407; WINTH., *Zool. Dan. Fiske*, p. 7, tab. 1, fig. 6; ID., Naturh. Tidskr., Kbhvn, ser. 3, vol. XII, p. 11; DAY, *Fish. G:t Brit.*, *Irel.*, vol. I, p. 79, tab. XXX; LILLJ., *Sv.*, *Norg. Fiskar*, vol. 1, p. 82; MOR., *Hist. Nat. Poiss. Fr.*, vol. 2, p. 98; MÖB., HCKE, Fische der Ostsee, p. 41.

Obs. It seems highly probable that the South European forms *Trachinus araneus* and *Tr. radiatus* which were distinguished by CUVIER, following SALVIANUS and DELAROCHE, may be regarded as being merely deep-sea forms and colour-varieties of the same species as *Tr. draco.* STEINDACHNER (l. c.) has pointed out the near relation between the first-mentioned forms; and the character (with the exception of the coloration) on which CUVIER and his successors grounded the species *Trachinus araneus*, the 7 rays in the first dorsal fin, has long ago been pointed out by KRØYER in *Tr. draco.* For the further elucidation of this point I may adduce a specimen of the Weever, a male from the north of the Sound off the fishing-village of Mölle, which is clearly an intermediate form between the supposed species last mentioned. Its length is 237 mm. There are 6 28 rays in the dorsal fin and $\frac{2}{30}$ in the anal. The greatest depth of the body is 19 % of the length — in the deepest typical specimen of *Tr. draco* that I have measured, it was 17.3 %. The least depth is 6.3 % of the length and 13.3 % of the second dorsal fin; in typical specimens of *Tr. draco* it is at most 5.9 % and 11.9 % respectively. The length of the base of the second dorsal fin is only 47.7 % of the length of the body; in typical specimens of *Tr. draco* it is at least 49.2 %. The length of the lower jaw is 13 % of the length of the body, 53.9 % of the length of the head, and 27.4 % of the length of the second dorsal fin; the highest corresponding ratios I have found in typical specimens of *Tr. draco* are 12.4, 52.4 and 24 respectively. Above the anterior corner of each eye there are 3 spines; in perfectly typical specimens of *Tr. draco* I have never found more than 2. As far as I can judge from six measured, typical specimens of *Tr. draco*, 3 ♂ and 3 ♀, however, it is most correct to regard this intermediate form, though a ♂ specimen, as being, in most of these peculiarities, the result of an abnormal development of the external female characters. — Cf. with regard to the influence of the sexual characters on the development of form in the Salmonoid family, SMITT, *Riksmuseets Salmonider*, Vet.-Akad. Handl., Vol. XXI, No. 8, pp. 204, 289, and several other passages.

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[a] In one species (from Chili) the preorbital bone is described as having a long, recurved spine, but it generally has one or two pointed or blunt protuberances instead.

[b] A proof of the slightness of the specific differences within this genus is given by KNER (Stzber. Akad. Wiss. Wien, Math. Naturw. Cl. LVI, 1 (1867), p. 717), who found no other difference between *Trachinus draco* and a Weever from Iquique than the smaller height (more elongated form) of the latter. Cf. GÜNTHER, *Cat. Brit. Mus.*, l. c. The generic name *Trachinus* owes its existence to ARTEDI (*Ichth.*, part. II, p. 74): "a τραχεινός, asper, *scaber*, quia ossicula pinnæ dorsalis valde aspera et aculeata sunt". CUVIER's derivation of the name from *δράκαινα* thus finds no support with ARTEDI.

[c] Sometimes 7, according to KRØYER.

[d] ,, 32 ,, ,, ,,

[e] ,, 32 ,, ,, ,,

The body of the great Weever is long, compressed, and thickest at the top of the head, but even there the greatest thickness is only $^2/_3$ of the greatest depth of the body. The length of the head varies between 21 and 24 % of the length of the body. The longitudinal diameter of the eyes in young specimens until about 250 mm. long, is between 21 and 20 % of the length of the head; in older specimens it is between 18 and 17 %. The scales of the body are oblong and set in very distinct, parallel, transverse rows, which run obliquely downwards and backwards, and are about 80 in number[a]. The cheeks, temples and operculum are covered with very small scales. The nostrils are small and situated above the preorbital bone: the anterior, which is the larger, has a grooved flap in the posterior margin; the posterior looks like a slit. The first three spinous rays in the first dorsal fin are fairly close together at the roots, the last three farther apart. The second or the third ray is the longest. We may sometimes find one or two of the rays longitudinally (sagittally) divided from in front. The fin may be hidden in its groove, but also admits of being sharply raised, so that the first ray points somewhat forward. The second dorsal fin, like the anal, which is still longer than it, is fairly uniform in height: the rays of the latter fin are thick and covered with a skin, which projects at the side almost like a flap. The caudal fin is truncate or only slightly concave. The pectoral fins are truncate, with 15 or 16 rays, the two uppermost being generally simple, the next 8, 9 or 10 quadrifid, or the last of them deeply bifid, and the last 5 or 6 thicker and bifid at the tip, or the lowest ones simple. In the axil is a broad dermal flap, which is scaleless, but in other respects resembles the structure which exists at the same spot in *Brama* (see above). The ventral fins are set close together and small, measuring between 8 and 10 % of the length of the body. The lateral line is almost perfectly straight and runs nearer the back than the belly, but slopes somewhat downwards at the base of the caudal fin.

The Great Weever is adorned with fairly bright colours, which in a strange way shift into one another in the form of broken, oblique, narrow bands. The first dorsal fin is dark in front, with dense, large, black spots and reddish brown rays, and light behind. There is a dark spot on the anal fin too, near the ninth ray. The posterior dorsal, the colour of which, with the exception of the spot, is reproduced in the anal, is whitish at the base, with a yellow stripe along the middle, and edged with blue. For the other details of the coloration we may refer to the figure.

As the abdominal cavity is fairly small, though it extends even behind the vent, the digestive canal lies in spiral coils. The stomach small, but fairly thick and firm. Six pyloric appendages. The liver consists of two lobes, the left considerably larger than the right, to which the gall-bladder is attached. No air-bladder. The urinary bladder long and fairly narrow. The generative organs are situated in the posterior part of the abdominal cavity. The dorsal column consists of 40—42 (10 or 11+30 or 31) vertebræ.

No external difference between the sexes in this species is yet known. Though COSTA states that the male has only 5 spinous rays in the first dorsal fin, while the female has 6, this difference, in Sweden at least, does not hold good. In the females, however, as a rule, the head seems to be longer and the distance from the middle of the tip of the snout (which is somewhat concave, as the preorbital bones project forward) to the beginning of the dorsal fin so much greater than in the males, that in 3 females and 4 males we have found the length of the lower jaw, without exception, in the former less, in the latter more, than 63 % of this distance. In all three females this distance is also considerably greater than the greatest depth of the body, while in the males it is only slightly greater or even less than the depth, which in the females varies between 81 and 88 % of the distance in question, in the males between 93 and 103 %.

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[a] In the lateral line their number is from 77 to 85.

The usual length of the Great Weever on the coasts of Scandinavia is between 22 and 30 cm.; but specimens are also found up to 37 cm. or a little more in length. It occurs along the whole west coast, from Bergen in Norway to the south of Scania and into the Baltic as far as the coast of Prussia, where it is, however, extremely rare. To the south it is common as far as the Mediterranean and the Black Sea. It generally lives alone; but at certain spots and certain seasons, periodically for a number of years, as Krøyer states, and especially during the summer months, whole boat-loads are taken in seines and bottom-nets (Danish *bundgarn*). It is greatly dreaded by all fishermen, who generally throw away all the Weevers they may happen to catch on the hook, in the net or the seine. The cause of this dislike and dread is the fact that the fisherman is often very painfully wounded by the sharp spinous rays of the first dorsal fin or the still stronger opercular spine. All these spines are furnished with a real poison-organ, which only needs special contractile muscles to be fully comparable to the corresponding organs of the venomous snakes. The rays of the first dorsal fin have on each side a comparatively deep groove, in which lies a small saccate poison-gland, superiorly attenuated into a fine duct. On the inside of the membrane of this glandular sac and of the duct we find an epithelium of cylindrical cells, filled with granules of a translucent yellow, 0.025—0.026 mm. broad and 0.1 mm. (or more) deep[a]. The poison-organ of the opercular spine is similar, but larger. This spine has on the outside a longitudinal ridge, the free margin of which is expanded on each side (upwards and downwards), and thus partly covers the two glands, the rest of which is covered by the skin and the extensors of the operculum. The quantity of poison which can enter the wound caused by one of these spines, is of course extremely small; but none the less its effects on several occasions have proved quite equal to those of the sting of the viper. "A strong young fisherman near Halmstad," says Dr. Ratzky[b], "had caught a Weever. In detaching it from the hook he was wounded in the finger. The wound gave him intolerable pain, and within an hour his arm, and even his head, were swollen. The swelling afterwards extended over the whole upper part of the body. Then followed painful headache and a desire to vomit. Several small blisters appeared along the arm. Hereto were added feelings of suffocation, deep mental depression and sleeplessness. The skin assumed a yellowish green colour over the whole body. Only three drops of blood had oozed from the wound. Several leeches were applied to the arm affected, and they died soon after, as if they had been poisoned . . . . The part immediately surrounding the wound became gangrened." By maintaining the bleeding caused by the leeches, by giving vapour and warm baths and applying opium plasters to the wound, the pain was relieved; but it was a month before the patient could be discharged from hospital. At the same time Dr. Landeberg of Strömstad wrote: "Most sufferers, who do not obtain speedy assistance, die on the sixth or seventh day of gangrene[c]." On other occasions, perhaps in consequence of the patient's constitution, the results of wounds caused by the Weever are, however, very slight, though violent pain always follows. The surest way of relieving the pain is to open the wound with a knife immediately and bathe it with cold water, dropped into the wound from a height, as long as any burning sensation is felt. In Bohuslän, says Fries, it is held to be a sovereign remedy to cut open the belly of the fish that has caused the wound, take out the liver and at once make the patient eat it. This remedy, strange as it may appear, is never omitted. "At Fredrikshavn," writes Schmidt, "it is a favourite pastime of the boys to fish for Weevers in the harbour, and when they go fishing, they take with them a bottle of hartshorn or, still more commonly, of aquafortis, which they apply to the wound immediately, if they are stung by a Weever."

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[a] According to Schmidt (l. c.) these cells have no special membrane, and he describes them, as well as the other cells in the epithelium, as supporting cells.

[b] Tidskr. f. Läkare och Pharm. 1834, p. 125.

[c] Death is, however, only an exceptional consequence. Schmidt (l. c.) knew of no such case. Still, he also regards as exceptional the circumstance which Krøyer asserts to be borne out "by his own experience and that of others," namely that the consequences of the sting of the Weever are sometimes no worse than those of the prick of a pin.

The Great Weever lives in water of a moderate depth with a sandy bottom. It buries itself in the sand and keeps in hiding in order more suddenly to attack its prey, which consists of small fishes and crustaceans. The spawning-season occurs during the summer months, when it goes nearest shore and is oftenest caught. Its flesh is said to be of excellent flavour, but, as we have mentioned, it is generally thrown away by the fishermen.

The common name of the species in Bohuslän is the one we have given. The same name occurs also in other districts, though the pronunciation is somewhat changed, e. g. *Färsing, Fjäsing* etc. In Norway, according to ASCANIUS, it is called *Kveise*. (FRIES, SMITT.)

LESSER WEEVER.

TRACHINUS VIPERA.

Fig. 35.

No preorbital or supraorbital spine. Anterior dorsal fin black, with 6 spinous rays. Second dorsal fin, as well as the anal, with about 24 rays. Cheeks naked. Greatest depth of the body about 20 or 21 % of the length.

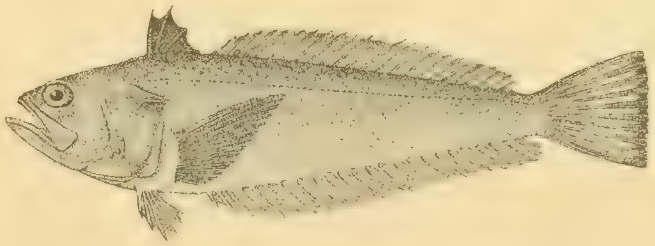

Fig. 35. Lesser Weever. Natural size.

R. br. 6; *D.* $6/24$; *A.* $\frac{1}{23}$; *P.* $1+8+5$; *V.* $^{1}/_{5}$; *C.* $x+10+x$; *L. lat.* 62 (+4 caud).

Syn. *Bodereau ou Bois de Roc*, DUHAM., *Tr. d. Pêches*, II, sect. VI, p. 135, tab. 1, fig. 2.

Trachinus vipera, CUV., VAL., *Hist. Nat. Poiss.*, vol. III, p. 254; KRØY., *Danm. Fiske*, vol. I, p. 71; NILSS., *Skand. Fn.*, *Fisk.*, p. 46; GTHR, *Cat. Brit. Mus.*, *Fish.*, vol. II, p. 236; STEIND., Stzber. Akad. Wiss. Wien, Math. Naturw. Cl., LVI (1867) 1, p. 697; DAY, *Fish. G:t Brit.*, *Irel.*, vol. I, p. 81, tab. XXXI; LILLJ., *Sv.*, *Norg. Fiskar*, vol. I, p. 89.

Among the older collections of the Royal Museum from the time previous to 1839, is a jar labelled "Trachinus draco, Färsing, — Suecia —," but containing, in addition to a specimen of the Great Weever, the Lesser Weever which we have figured here (fig. 35). The reasons for the inclusion of this species in the Scandinavian Fauna which have been given by KRØYER, NILSSON and LILLJEBORG, thus find a further support. With this exception the Lesser Weever has not been observed on the coasts of Scandinavia. In England and France and in the Mediterranean, on the other hand, it is as common as the preceding species, if not more so, and is all the more feared as its small size — it is said never to exceed 135 mm. in length — renders it less easy to distinguish, when it is caught with other fishes. Its colouring, too, is duller: the back is yellowish gray, the sides silvery and the belly yellow; but the scales are punctated with brown dots, which are collected into a row of spots below the lateral line. The top of the head is marked with spots formed of black dots. Instead of describing it we shall give in the following table a comparison between the specimen of the Lesser Weever which belongs to the Royal Museum, and 7 specimens of the preceding species.

	Trachinus vipera.	*Trachinus draco.*		
			Average.	
		♀	2 ♂♂ + 1 ♀	2 ♂♂ + 1 ♀
Length of the body in millimetres	83	189	229	285
1) Greatest depth of the body in % of the length of the body	21.1	15.3	17.3	16.9
2) ,, ,, ,, ,, ,, ,, ,, ,, ,, distance between the first dorsal fin and the tip of the snout	94.6	81.7	93.9	93.8
3) Length ,, ,, head ,, ,, ,, ,, length of the body	24.7	22.2	22.5	22.5
4) ,, ,, ,, lower jaw ,, ,, ,, ,, ,, ,, ,, ,,	14.7	11.6	11.9	11.6
5) ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, head	59.5	52.4	52.9	51.6
6) ,, ,, ,, ,, ,, ,, ,, ,, ,, distance between the first dorsal fin and the tip of the snout	66.0	62.0	64.6	64.4
7) ,, ,, ,, ,, ,, ,, ,, ,, ,, length of ,, second ,, ,,	33.6	23.6	23.9	22.7
8) Longitudinal diameter of the eye ,, ,, ,, ,, ,, ,, the head	24.4	21.0	20.5	17.8
9) ,, ,, ,, ,, ,, ,, ,, ,, ,, least depth of the tail	83.3	86.2	77.1	69.5
10) Distance between the first dorsal fin and the tip of the snout in % of the length of the body	22.3	18.7	18.4	18,1
11) Length of ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,,	10.1	9.4	9.4	9.5
12) ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, lower jaw	69.0	80.9	79.2	81.7
13) ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, second dorsal fin	23.1	19.1	18.8	18.7
14) Least depth of the tail in % of the length of the body	7.2	5.4	5.9	5.8
15) ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, head	29.2	24.3	26.5	25.6
16) ,, ,, ,, ,, ,, ,, ,, ,, ,, distance between the first dorsal fin and the tip of the snout	32.4	28.7	32.4	32.0
17) ,, ,, ,, ,, ,, ,, ,, ,, ,, length of the lower jaw	49.2	46.4	50.2	49.6
18) ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, first dorsal fin	71.4	57.3	63.4	60.5
19) Length of the second dorsal fin ,, ,, ,, ,, ,, ,, ,, body	43.7	49.2	49.9	51.1

Where the ratios in this table run uniformly through all four columns, rising, as in 19, or falling, as in 8, they naturally indicate a common direction of development, in which our specimen of *Trachinus vipera*, as being least, represents the lowest stage; but where this is not the case, especially where difference of sex in other fishes, too, takes a prominent place, as in 2, 6, 15, 16 and 17, we see that *Trachinus vipera* — as far as we can judge from one specimen — represents a branch of development where the male characters are predominant.

Fam. BATRACHIDÆ.

Body tadpole-shaped, posteriorly compressed, anteriorly terete with broad, flat head. Scales small and cycloid. Eyes small, and directed more or less upwards. First dorsal fin short, with strong spinous rays; second dorsal long; anal similar in form to the second dorsal, but shorter. Basal bones of the pectoral fin flat in the external (distal) part, but elongated, and anteriorly (in the proximal part) narrow[a]. *Jaw-teeth of uniform size and pointed, set in a card, or some of them larger and obtuse. Vomer and palatine bones also furnished with numerous teeth. Lips fringed. Lateral line continuous or broken; the rest of the system of the lateral line and of the muciferous ducts highly developed. Only three perfect branchial arches. Gill-openings confined to the sides in front of the pectoral fins. No pseudobranchiæ. Air-bladder more or less completely divided in a longitudinal direction, or broken up into two chambers with a communication between them.*

By the broad, flattened head and the loose, slippery skin, which is covered with extremely small scales or even naked, these fishes are placed in about the same relation to the Weevers as the Cottoids to the Scorpænoids. We have further proof that the natural place of the Batrachoids in the system is by the side of the Weevers, not only in the arrangement of the fins and the other characters given above. Both these families have another common peculiarity in the poison organs which they possess. GÜNTHER[b] has described these organs in the genus *Thalassophryne* from Central America, which belongs to this family. They are situated, as in the Weever, on the operculum and in the spinous rays of the first dorsal fin, but are still more highly developed. The opercular spine is perforated, like the fangs of the true vipers, and not merely grooved, as in the Weever, the spines of which in this respect resemble the fangs of venomous colubrine snakes.

By the side of this poison organ in some Batrachoids is another, which, however, belongs rather to the system of the lateral line and of the muciferous ducts, and the venomous properties of which are not yet fully demonstrated. The advanced development of the system of the lateral line is not confined to the head, with the usual, but numerous, branches, especially in the suborbital ring, where there is sometimes a row of pores hidden under a peculiar, longitudinal, dermal flap; but also extends to the trunk. This appears most distinctly in the genus *Porichthys*, from both the east and the west coasts of America, in which the pores of the lateral line, at least during youth, are especially distinguished by a golden-yellow, cornea-like substance in the openings. In this species the branches of the lateral line run, as usual, in graceful curves on the head and the middle of the sides, but also on the operculum and the branchiostegal membrane, as well as on the lower side of the lower jaw and on the belly itself, in curves which surround the ventral fins, ascend on the anterior side of the lobate base of the broad, pectoral fins, and surround the vent. Another branch slopes down from the axil to the lower part of the side, and then follows the base of the anal fin for some distance. Another branch of the lateral line, a dorsal canal, runs close to the base of the second dorsal fin. In the genus *Batrachus*, on the back of the pectoral fins, we find a row of pores from which oozes a slimy moisture, and in the axil of these fishes is a cavity beneath the skin, which in some species opens into a hole in the corner of the shoulder. The properties of the secretion formed in this cavity are not yet known; but GÜNTHER[c] endeavours to explain it by a comparison with a similar structure in the same part of the body in certain Siluroids, where the poisonous properties of the secretion are more probable, as it is emitted at the base of the defensive weapons these fishes possess in the strong, serrated spines of the pectoral fins.

The ventral fins of the Batrachoids are remarkable not only for their jugular position, but also for their structure. Their spinous ray is considerably stunted in growth, and is firmly united to the base of the first soft ray. The latter, on the other hand, is all the longer, is closely and distinctly articulated, but simple (undivided), and on the outside has a dermal fold, which is broader at the middle and generally marked with transverse stripes, and which gives this ray an acinaciform shape. The second soft ray is so deeply branched, that it appears to be formed of two rays: inside of this ray we sometimes find in some species, at its base, a small cartilaginous disk, which is perhaps to be regarded as a remnant of those parts of these fins which have disappeared with this exception.

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[a] In *Batrachus Pacifici*, the only species the skeleton of which I have been enabled to examine, I find 5 basal bones belonging to the pectoral fins, or one in excess of the ordinary number. The uppermost is narrow and terete, and has no rays of the pectoral fin articulating with it. The 3rd and 4th from the top are considerably narrower than the rest. The lowest of all is the largest and broadest.

[b] Proc. Zool. Soc. 1864, p. 155.

[c] *Introd. to Study of Fish*, p. 192; *Handb. Ichthyol.*, p. 129.

The singular appearance of the Batrachoids is further enhanced by the filaments which fringe the cheeks and the margins of the jaws (lips), and often occur even on the upper margin of the orbit.

The suborbital ring is very little developed; it is generally without any osseous structure whatever[a].

In order to comprehend the relation of these fishes to the other *Anomalopteri*, especially to the *Gobiomorphi* it is of interest to remember the observation made by Storer, that the fry are furnished with a ventral disk, which disappears with age, and with which they attach themselves to stones and rocks.

The family contains only few species[b], most of them belonging to the tropic seas.

Genus BATRACHUS.

Three spinous rays in the first dorsal fin. Suboperculum and operculum furnished with spines. Head naked; the trunk with or without scales. Caudal fin with about 12 branched rays.

Obs. Jordan and Gilbert[c] suggest another definition of this genus, in which, according to their opinion, the European species should not be included. They refer to this genus only those species which are completely destitute of scales. Whatever principles are to be followed in the definition of the genera — convenience alone cannot demand many genera within a family with so few species — the European species must, in any case, be retained within the genus *Batrachus*, for this species, as even Jordan and Gilbert mention, was the generic type employed by Block-Schneider (l. c.), who introduced the genus into the system.

If we retain Günther's division of this family into genera, most of the species belonging to it must be referred to this genus, which consists of voracious shore-fishes, belonging to the tropic and temperate seas, and living on small fishes, crustaceans and mollusks.

THE EUROPEAN TOAD-FISH.

BATRACHUS DIDACTYLUS.

(Plate X, fig. 1).

Trunk covered with scales. The axillary sac opens into the upper corner of the axil. Three opercular spines, the two uppermost belonging to the operculum proper, the lower one to the suboperculum. Jaw-teeth and palatine teeth pointed. No filaments above the eye. Second dorsal fin with 20 (21) rays; anal with 16 (17).

R. br. 6; *D.* 3·20 l. 21[d]; *A.* 16 l. 17; *P.* 22–25[e]; *V.* $^1{}_2$; *C.*[f] *x* + 12 + *x*.

Syn. *Gadus Tau*, Bloch, *Naturg. Fish. Deutschl.*, II, p. 170, tab. LXVII, fig. 2 et 3; Bl., Schn. (*Batrachus*), *Syst. Ichthyol.*, p. 44.

Batrachus didactylus, Bl., Schn., l. c., p. 42; Gthr, *Cat. Brit. Mus., Fish.*, III, p. 170; Steind., Stzber. Akad. Wiss. Wien, Math. Naturw. Cl., LVII (1868), I, p. 419, tab. V; Malm, *Gbgs, Boh. Fn.*, p. 466; Winth., Naturh. Tidskr. Kbhvn, ser. 3, vol. XII, p. 21; Hansen, *Zool. Dan., Fiske*,

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[a] A preorbital bone, however, is sometimes present, e. g. in *Batrachus Pacifici*.

[b] 12 species, distributed among the three genera mentioned above, are adopted in Günther's *Catalogue*.

[c] *Syn. Fish. N. Amer.*, Bull. U. S. Nat. Mus., No. 16, p. 750.

[d] Sometimes 22, according to Steindachner.

[e] According to Steindachner: in Nilsson's specimen we have found *P.* 1 + 20 + 1.

[f] *C.* 13 according to Nilsson. The caudal fin of the specimen is damaged. Bloch found only 12. Agassiz found only 10 branched rays in the caudal fin. In a specimen from Cadiz, the original of our figure, and obtained for us by Prof. Steindachner, we find *C.* 2 + 12 + 1. In another specimen from Cadiz, presented to the Royal Museum by Professor Giglioli of Florence, *C.* 1 + 12 + 2.

p. 42, tab. VII, fig. 5; Lill., *Sv., Norg. Fisk.*, vol. I, p. 749.

Batrachus borealis, Nilss., *Prodr. Ichth. Scand.*, p. 99; Kroy., *Danm. Fiske*, I. 473 et 603; Nilss., *Skand. Fn. Fisk.*, p. 254; Id., Öfvers. Vet.-Akad. Förh. 1863, p. 502.

Batrachus punctatus, Agass., Cuv. (in Spix, *Pisc. Brasil.*, p. 133, tab. LXXIV); *Batr. conspicillum*, *B. punctulatus*, *B. barbatus*, Cuv., Val., *Hist. Nat. Poiss.* XII, pp. 495--498; *Batr. planifrons* et *B. algeriensis*, Guich., *Expl. Scient. Alger.*, *Poiss.*, p. 81, tab. 5; vide Gthr et Steind. (l. c.).

The numerous names which this species has borne are a sufficient proof how greatly its appearance may vary. This is true first of the colouring, which varies considerably according to age. The ground colour is brown, shading into black, on the lower part of the sides becoming paler or changing into white between the large brown or blackish spots which occur even in the form of oblique bands on the unpaired fins, while the spots of the pectoral fins are smaller. Young specimens, according to Steindachner, have black, transverse bands on the top of the head, and one black band on the sides of the head, starting from the inferior orbital margin downwards in a forward direction, and another in a backward direction. These bands, like the boundaries of the spots on the body, become indistinct or even vanish with age, while the skin grows thicker and the scales of the body also become indistinct.

With regard to the changes of growth in the form of the body Steindachner, who had examined specimens from about 100 to 260 mm. in length, states that the diameter of the eyes changes from $^1/_5$ to $^1/_7$ of the length of the head to the tip of the uppermost opercular spine, and that in young specimens the length of the snout is less than the diameter of the eye, in old ones more. The length of the head varies between $^5/_{16}$ and a little more than $^1/_3$ of the length of the body; its breadth increases with age[a]. The dental equipment of the jaws and of the palate also increases with age: in young specimens there are two rows of teeth in the front of the lower jaw, in older ones three or four; in the former 3 rows in the front of the intermaxillary bones, in the latter 5; in the former one row on the head of the vomer, in the latter two transverse rows; and though the palatine teeth are set in one row, in the oldest specimens we find two rows in the front part of the palatine bones.

Of the numerous peculiarities described by Günther (l. c.) in the osteology of the Toad-Fish, we shall call attention only to the singular bones which serve as a connecting link between the coalescent first and second neural spines (to which the supraoccipital bone is also united by a process) and the upper part of the clavicular bones, which articulate with these two bones, as is also shown in Steindachner's figure. These bones correspond to the first pair of ribs; and in *Batr. pacifici* at least, we find distinct ribs attached just below the hind part of the connexion between the neural spines mentioned. The posttemporal bone in this species, as in *Lophius*, is united to the mastoid bone (*epioticum*). The top of the supraclavicular bone articulates with the lower side of the mastoid process thus formed.

According to Steindachner *Batrachus didactylus* is common near Cadiz and Gibraltar. Guichenot, through Deshayes, obtained a specimen from Oran. Near Lisbon too, the species is known; and Bloch (Schneider) had specimens of it from Guinea. The Mediterranean and the neighbouring parts of the Atlantic thus seem to be its true home; but north of Portugal it has been found, to the best of our knowledge, on only one single occasion, and that too, at a considerable distance from its ordinary habitat. This find is one of the treasures in the Museum of Lund University, and is a specimen 2 dm. in length, which, about the year 1820, was procured by Baron Gyllenstjerna from some fishermen belonging to the fishing-village of Mölle near Kullen, and presented by him to Nilsson, who has described it (l. c.). In its stomach were found a whelk (*Buccinum reticulatum*), a crab (*Cancer depurator*) and a fragment of an *Ophiura*.

Of the way of life of the European Toad-Fish we have no other detailed information; but of a species very closely related to it, the North American *Batrachus tau* (*The common toadfish*) Storer[b] has given a very noteworthy description. This fish, as well as, in all probability, the European species, generally lives in shallow water near shore. It prefers shallow inlets with a sandy or muddy bottom, where it can hide among the weeds (*Zostera marina*), or takes refuge under stones among the rocks. Where the water is only a few inches deep at low tide, one may often see the sand scratched away at the side of a stone so as to form a hollow, perhaps a foot in width, which extends under the stone. If one approaches cautiously, one may see the head of a Toad-Fish peep out. The fish is not easy to see, but with a little care you can distinguish its broad mouth, the fine, graceful filaments on its jaws and the rest of its head, and its eyes, which are really beautiful. Occasionally, too, a large portion of its body is in sight; but at the slightest noise it draws back under the stone, soon to reappear once more. It lies here perhaps only in order safely to conceal itself, or perhaps to watch for its prey; but during July and August it seems to be engaged otherwise: at this time it apparently keeps guard over its eggs or its young. The eggs — of the size of dust-shot — adhere to the bottom of the stone, or, it may be, several hundred tiny Toad-Fish have attached themselves there by the help of the disk which surrounds the base of the still unabsorbed yolk of the egg. If one drives the parent fish from the hole, it soon hurries back again[a]. In winter, in Massachusetts, the northern portion of its geographical range, the Toad-Fish apparently withdraws on occasion to deep water; but during this season it generally buries itself in the mud and lies there in a torpid state.

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[a] Bloch says that his specimen 1 ft. in length was 4 in. broad.

[b] Mem. Amer. Acad. Arts. Sc., n. ser., vol. V (1855), p. 272.

If our European Toad-Fish, as is highly probable, leads the same or a similar life and is also a distinct shore-fish, it is remarkable in the highest degree that it has been found off Kullen, but neither on the coast of France, nor in any other place north of the Spanish Peninsula. Perhaps Nilsson is right in his assumption that this fish has been found on more than one occasion and at more than one spot, but has been thrown away by the fishermen on account of its resemblance to the *Cottidæ*.

Fam. **LOPHIIDÆ** or **PEDICULATI.**

Form of the body variable, flat or oval. Skin naked, without scales, or with scattered protuberances or spines. Eyes small. First dorsal fin more or less entirely broken up into free, tentacular or spinous rays. Anal fin, and sometimes the second dorsal, comparatively short. Basal bones of the pectoral fins brachiate, two or three in number; the rays articulating only with the lowest of these bones. Jaw-teeth pointed, cardiform, mobile, of uniform shape, but often varying in size. Gill-openings set in the form of large or small holes behind or above the base of the pectoral fins. Branchiostegal rays 6. Gills $2^{1}/_{2}$, *3 or* $3^{1}/_{2}$. *Pseudobranchiæ generally wanting*[b]. *System of the lateral line of average development. Rays of the pectoral fins undivided. Rays of the caudal fin about 9. Skeleton only slightly ossified.*

The genus *Lophius*[c] of Artedi and Linnæus is replaced in the works of modern authors either, according to Cope[d] and Bleeker[e], by a special order, *Pediculati* or *Antennarii* — the three species of Linnæus (*Lophius piscatorius*, *L. vespertilio* and *L. histrio*) corresponding to the three families within this order as defined by Bleeker — or according to Bonaparte[f] and Günther[g], by a family among the Acanthopterygians, the place of which in the system according to CUVIER'S[a] opinion is near the Gobioids, but according to GÜNTHER'S[b] here by the side of the Trachinoids. To raise the family to the rank of an order, and thus give it an independent place in the system, is indeed the most convenient course for the systematizer — and on this point it is probable that some freedom must always be granted to individual taste — but the procedure is to a certain degree misleading, if it places us in danger of overlooking the natural connexion between the forms. But COPE, as well as his successors GILL and JORDAN and GILBERT, although they created such an order, have reminded us of the connexion between these fishes and the rest of the Eleutherognates[c]. Furthermore, the most distinctive characters of the *Pediculati* have their original patterns in the Batrachoids. Even in the latter the branchiostegal rays are extraordinarily long; and it is, in the first place, a greater (even if it be considerably greater) elongation of these rays — in conjunction with an increase of the membrane extended by them — which in the Lophioids gives the gill-cavity so great a width and length posteriorly that it extends under the base of the pectoral fins, and, in *Lophius*, even behind it. This membrane is also extended, however, by other rays: in *Lophius* from the upper part of the operculum goes a long and narrow process, which at the top assumes the form of a ray, and curves down through the branchiostegal membrane towards the angle of the pectoral fins[d]; and other rays, about 20 in number, form a finlike continuation of the suboperculum in the branchiostegal membrane. The great elongation of the basal bones of the pectoral fins is also prefigured, as we have already seen, in the Batrachoids. In the Lophioids the lowest basal bone is always wanting, and in *Lophius* the uppermost as well; but the lowest of the remaining ones has taken the lead in development, and supports the whole of the broad pectoral fin on the hind margin of its wide, upturned top. The breaking-up of the first dorsal fin into free tentacles and spinous rays and its removal towards the head, so far that the first ray may be set right out on the snout, is in fact no greater difference from the preceding family than that between the Sucking-fish (*Echeneis*), with its sucking-disk, and the typical Scombroids. The singular extension of the mastoid bones (*ossa epiotica*) in the Lophioids, where these bones, as BRÜHL[e] has shown, force themselves between the supraoccipital bone and other parts of the occipital region and there unite, a peculiarity which COPE has mentioned as a character of the *Pediculati*, appears both in *Balistes* (among the Plectognates) and in *Anarrhichas* (among the Blennioids). Again, the character which has been assigned by COPE to the Plectognates, namely the union of the posttemporal bone to the skull by means of an osseous connexion with the mastoid bone (*epioticum*), has been shown by LILLJEBORG[f] to belong also to *Lophius*. In the *Lophiidæ*, as in the *Batrachidæ*, there are only two upper pharyngeals.

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[a] These observations have received from Ryder (American Naturalist, vol. XX (1886), p. 77) the additions that it is the male that watches the eggs and the fry, that the latter remain fast, as we have described, until the yolk-sac, which forms the adhesive disk, has been absorbed, and that the young are thus much better capable of free motion, when they leave the egg, than those of other fishes.

[b] In *Lophius*, it is true, the pseudobranchiæ are present, but they are very small.

[c] Art., *Gen. Pic.*, p. 62; Lin., *Syst. Nat.*, ed. X, tom. I, p. 236.

[d] Trans. Amer. Phil. Soc., Philad., N. ser., vol. XIV, art. V, p. 458 (*Pediculati*). Cf. also Gill, *Arr. Fam. Fish.*, Smiths. Misc. Coll. No. 247, pp. XLI and 2. *Cat. Fish. E. Coast North Amer.*, Smiths. Misc. Coll. No. 283, p. 6; Jord., Gilb., *Syn. Fish. N. Amer.*, Bull. U. S. Nat. Mus., No. 16, p. 843.

[e] *Atl. Ichth.*, tome V, p. 1 (*Baudroies* = *Antennarii*).

[f] Isis, 1833, p. 1200 (*Lophidæ*).

[g] *Cat. Brit. Mus. Fish.*, vol. III, p. 178.

The family *Lophiidæ* is further distinguished by the most fantastic forms assumed by the body; and, as usual, the form of the body is adapted to the manner of life. Some forms are bottom-fishes with the body, in most cases at least, flattened; others again prefer to swim, or literally to crawl, among seaweeds and coral, and thus have the body strongly compressed laterally. All are comparatively poor swimmers; but some travel long distances by drifting with loose tufts of seaweed which are borne away by wave and tide, or by independently floating in the same way at the surface, by the help of the air with which they have inflated their stomach. All are voracious fish of prey, the small ones being naturally restricted in ordinary circumstances to smaller victims; but as a proof of their capacity in this respect we may mention the fact that on the voyage of the "Challenger" a specimen belonging to this family was taken in the Atlantic at a depth of 1,800 fathoms, namely a *Melanocetus Johnsonii* $3^{4}/_{5}$ in. in length, with a twisted *Scopelus* $7^{1}/_{2}$ in. long and 1 in. deep in its stomach, which was incredibly distended.

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[a] Mém. Mus. Hist. Nat. Tome III (1817) p. 420. Cf. also CUV., *Règne Animal*, éd. 2, tome II, p. 249 and CUV., VAL., *Hist. Nat. Poiss.*, tome 12, pp. 335 etc.

[b] Systematic Synopsis, l. c.; *Introd. Study of Fisches*, p. 469, *Handb. Ichthyol.*, p. 332.

[c] "They connect with the *Percomorphi* by the *Blenniidæ* and *Batrachidæ*," COPE. "Their relations are more intimate with the Batrachoid and Blennioid forms, and doubtless they have descended from the same common progenitors," GILL.

[d] BLEEKER regards this process as corresponding to the whole operculum. The large, thick and angular bone of fairly uniform size which articulates superiorly with the hyomandibular bone — with the outside of which the preoperculum has coalesced like an irregular, longitudinal bar — would then correspond to the suboperculum, while this bone, according to the general opinion, could be represented only by the triangular bone, furnished with strong spines in front and with rays behind, which is attached to the lower end of the operculum. The interoperculum, in *Lophius* a triangular, foliate bone, armed with a spine at the middle of the posterior margin, and, as usual, joined by a ligament to the angular part of the lower jaw, is not subject to this difference of opinion.

[e] *Osteologisches aus dem Pariser Pflanzengarten*, taf. 2, fig. 3, 4, 8, 13; taf. 6, fig. 4.

[f] *Sv., Norg. Fiskar*, vol. I, 767.

Of this family we know about 60 species distributed among 14 or 15 genera. Two of these genera, one species of each, may be included in the Scandinavian fauna, the one species, however, only as an occasional visitor. The family belongs chiefly to the Tropics, but also lives in the temperate seas. Most of the species inhabit the upper regions of the ocean or keep close in shore; but some species (at least 8) belong to the deep-sea fauna.

Genus LOPHIUS.

Head large, broad, and, like the greater part of the body, depressed, with large, horizontal gape, and well armed with spines on the sides of the skull[a] *and also on the suboperculum and the clavicular bone. Body naked (without scales), but furnished with numerous fringes. Lower jaw, intermaxillaries, palatine bones, and the outer corner of the broad head of the vomer, as well as the upper and lower pharyngeals, strongly armed with teeth. Eyes set about midway in the upper side of the head*[b]. *In the first dorsal fin 6 rays, the first 3 being tentacular and free from each other*[c]. *Three gills*[d]. *No gill-rakers. The gill-openings are large holes behind the pectoral fins, which have only two basal bones. Two pyloric appendages. No air-bladder. Rays of the caudal fin at most 8; the uppermost and lowest of these rays undivided. Posttemporal bone united to the mastoid bone.*

The genus *Lophius*, with its two or perhaps four species, is known on the coasts of all parts of the world except Australia and South America. These fishes should really be regarded as shore-fishes; and at least during youth they live in shallow water, but when older, they withdraw to greater depths. The Atlantic species, if there be more than one, are distinguished from the Pacific species — which may perhaps be also reduced to one, to judge by the descriptions — by the greater number of rays in the second dorsal and the anal fin, and by the lack of colour in the mouth behind the hyoid bone.

THE FISHING FROG OR THE ANGLER (SW. MARULKEN OR MERULKEN).

LOPHIUS PISCATORIUS.

Plate X, fig. 2.

Rays of the second dorsal fin 11 at least[e]; *rays of the anal fin at least 9*[f]. *Dorsal side chocolate-coloured or gray, streaked or grained with black or brown, and sometimes with scattered, small, round, white spots; ventral side white, but the tops of the pectoral, ventral, and anal fins, during youth at least, black or blackish brown.*

R. br. 6; *D.* 1 + 1 + 1 + 3 | 11 à 12; *A.* 9–11; *P.* 26 à 27[g]; *V.* $^{1}/_{5}$; *C.* 1 + 6 + 1.

Syn. Βάτραχος ἁλιάς, ARISTOT., cett.; *Rana*, OVID., cett.; *Rana marina*, CIC., cett.; *Rana piscatrix*, BELON., cett.: vide ARTEDI, *Lophius* ore cirroso, *Syn.*, p. 87.

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[a] On the epiotic (mastoid), pterotic (squamosa), parietal, and frontal bones, and on the upper part of the beginning of the palatine bones.

[b] There is no suborbital ring, as also seems to be the case in the other genera of the family, and as is most generally the case in the Batrachoids.

[c] The first is especially well suited for its purpose as a mobile, attractive bait: it is bifoliate at the top, and can be moved in all possible directions by means of a pivoted articulation with the interspinal bone which lies on the snout. This interspinal bone is common to the two first rays; the interspinal bone of the third lies farther back on the top of the head.

[d] Still there are, as usual, 4 branchial arches besides the lower pharyngeals. It is the fourth arch that is without branchial lamellæ.

[e] According to NILSSON 9: according to FABER 8.

[f] According to NILSSON and FABER 8.

[g] *P.* 23, according to VALENCIENNES, FABER, NILSSON, and MOREAU.

Lophius piscatrix, Lin., *Mus. Ad. Frid.*, I, p. 55.

Lophius piscatorius, Lin., *Syst. Nat.*, ed. X, tom. I, p. 236; *Fn. Suec.*, ed. II, p. 108; Müll., *Zool. Dan. Prodr.*, p. 38; Retz., *Fn. Suec. Lin.*, p. 308; Faber, *Fische Isl.*, p. 55; Ekstr., Gbgs Vet., Vitt. Samh. Handl., Ny tidsf., häft. 1, p. 38; Nilss., *Prodr. Ichth. Scand.*, p. 101; Cuv., Val., *Hist. Nat. Poiss.*, vol. XII, p. 344, tab. 362; Kr., *Danm. Fiske*, vol. I, p. 446; Nilss., *Skand. Fn. Fisk.*, p. 245; Gaim., *Voy. Isl.*, *Poiss.*, tab. 19; Gthr, Ann. Mag. Nat. Hist., ser. 3, vol. VII, p. 190, tab. X, fig. C—E; Id., *Brit. Mus. Cat., Fish.*, vol. III, p. 179; Steind., Stzber. Akad. Wiss. Wien, Math. Naturw. Cl. LVII (1868), I, p. 421; Coll., Vid. Selsk. Forh. Christ. 1874, Tillægsh. p. 68; Cederstr., Öfvers. Vet.-Akad. Förh. 1876, No. 4, p. 65; 1879, No. 2, p. 60; Malm, *Gbgs, Boh. Fn.*, p. 466; Winth., Naturh. Tidskr. Kbhvn, ser. 3, vol. XII, p. 21; Day, *Fish. G:t Brit., Irel.*, vol. I, p. 73, tab. XXIX; Mor., *Hist. Nat. Poiss., Fr.*, vol. II, p. 180; A. Agass., Proc. Amer. Acad. Arts., Sc., vol. XVII, p. 280, tab. XVI, fig. 2—5, tab. XVII et XVIII; Möb., Hcke, *Fisch. Osts.*, p. 42; Lillj., *Sv., Norg. Fiskar*, vol. I, p. 757; Hansen, *Zool. Dan., Fiske*, p. 43; tab. VII, fig. 6.

Lophius barbatus, Montin, Vet.-Akad. Handl. 1779, p. 187, tab. VII.

(?)*Lophius budegassa*, Val., Bonap., cett.

Lophius eurypterus, Düb., Kor., Vet.-Akad. Handl. 1844, p. 63, tab. III, fig. 1—3; Nilss., *Skand. Fn., Fisk.*, p. 251.

The monstrously large, flat head, with the broad, wide gape, give the form of the Angler an ugly, not to say hideous, appearance. When distended, the breadth of the head is considerably greater than its length: its breadth straight across the subopercular spines is then about $^{2}/_{5}$ of the length of the body, or about equal to the distance from the tip of the snout to the end of the first dorsal fin. The depth at this point is only from $^{1}/_{9}$ to $^{1}/_{7}$ of the length of the body; and the length of the head from the tip of the snout (the tip of the upper jaw) to the occiput is only slightly more than $^{1}/_{4}$ of the length of the body (from the tip of the snout). The anterior part of the body thus forms an almost circular disk, from the posterior quadrants of which extend the pectoral fins. Behind this disk the body is still flat, but considerably more slender, and it tapers evenly backwards, until at the base of the caudal fin it becomes laterally compressed. The pectoral fins, when extended, are of the rounded form shown in the figure, and look like the spread wings of a bird; when folded, however, they are somewhat truncate. The singular appearance of the fish is also greatly increased by the breadth of the mouth, which is about $^{1}/_{4}$ of the length of the body, and by the projecting, but rounded, lower jaw. Just in front of the middle of the head are set the squinting and comparatively small eyes[a], with the iris marked with yellow radiating streaks. They are separated by the deeply concave interorbital space, the margin of which rises above them in the form of two strong spines, the posterior pointing upwards or slightly backwards, the anterior in a forward direction. This supraorbital margin is continued anteriorly by a row of bony protuberances. Among the other spines of the head, as we have mentioned above, are two on the upper part of the anterior end of the palatine bones, rising behind the articulation of the superior maxillaries. Between these palatine spines, on each side of the snout, is a clavate stalk, at the top of which is the smelling-organ. When depressed, this stalk is like a common dermal flap, but on closer examination we may find the one nostril on its anterior side, the other on its inside. Between these openings lies a cavity lined with the foliate mucous membrane of the smelling-organ, and in the centre of the stalk runs the olfactory nerve.

Midway between these nasal stalks stands the first, tentacular ray of the dorsal fin, with its green, foliate, dermal appendage at the top, and at different distances behind it the one halfway along the snout, the other at the middle of the top of the head — stand the other two, long, free rays, with filiform, pointed tips, but fringed along the sides with dermal appendages. Behind each ray, at the base, is a small fin-membrane. The three rays, at least the first two, in the first continuous dorsal fin, which are united at the base by a more developed fin-membrane, are like the former rays fringed and flexible. The distance between this fin and the tip of the snout is about a third of the length of the body; and the space between it and the second dorsal is about equal to the space between the eyes. The extent of the second dorsal fin, like that of the anal, is indeed difficult to fix, as these fins are deeply imbedded in the loose skin; but the length of the former, which begins almost vertically above the vent, is a little less than the length of the head from the tip of the snout to the occiput, and the height is about $^{2}/_{3}$ of the length of the head and almost equal to the length of the longest rays in the pectoral fins. The anal fin begins just in front of the perpendicular from the fifth

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[a] In a specimen 144 mm. in length (from the tip of the snout) the longitudinal diameter of the eye is 22 % of the length of the head from the tip of the snout to the occiput, and 49 % of the distance between the eye and the middle of the snout (the length of the snout); but in a specimen 359 mm. in length these proportions have sunk to 12 and 34 respectively.

(the longest) ray in the second dorsal, and ends a little farther back than this fin; its height (the length of the longest ray — the fourth or fifth) is about equal to that of the second dorsal. The hind margin of the caudal fin is truncate or slightly rounded. Its length is somewhat greater than that of the pectoral fins. The ventral fins, the creeping organs of the fish, are set far forward on the lower side of the head, just behind the perpendicular from the hind margin of the eye. They are obliquely rounded, but almost truncate in form. Their length is about equal to, or at least $^4/_5$ of that of the longest rays in the pectoral fins.

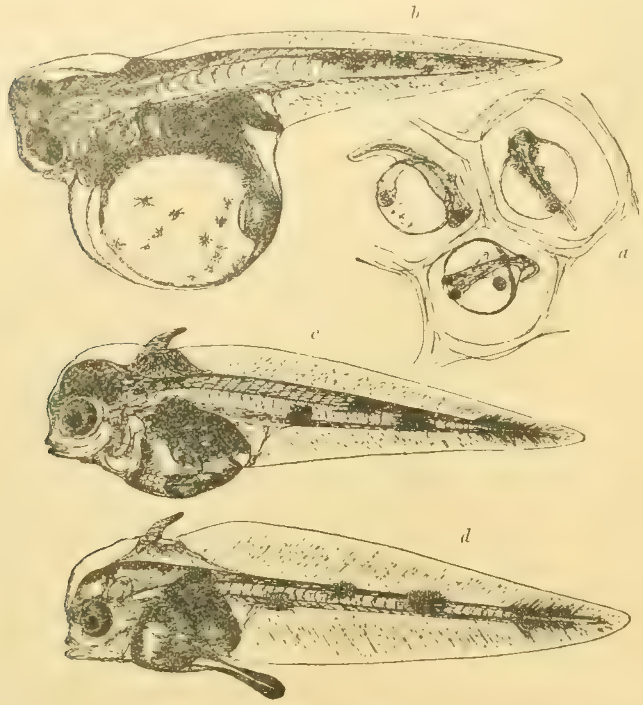

Fig. 36. Embryos and young of *Lophius piscatorius*. Magnified. *a:* three eggs, enveloped in the gelatinous membrane, and each containing an embryo; *b:* one of these embryos with external (pendent) yolk sac, taken out of the egg; *c:* a young specimen already hatched, with the yolk-sac almost entirely absorbed, and with a clavate stalk at the bottom of the sac, which is the rudiment of a ventral fin; *d:* another young specimen, with the yolk-sac completely absorbed, and with the stalk more developed. After ALEX. AGASSIZ.

The naked and loose, slippery skin is chiefly distinguished by its numerous fringed appendages, which are wanting, however, on the lower side of the body, their arrangement thus bearing out the assumption that their object is to give the fish when at rest at the bottom and when seen from above, a certain resemblance to the vegetation growing there. These fringes, which assume the form of lobate leaves of seaweed, vary in size, and are most highly developed at the edges of the body, but are also scattered over the whole of its upper side and over the upper side of the pectoral fins. The fringe on each side of the forehead, above the middle of the eye, is especially remarkable. As a rule, too, a row of small fringes coasts the lateral line and its branches on each side.

The course of the lateral line may easily be distinguished by the white spots, or small white transverse streaks on its pores. The lateral line proper starts from the temporal region, about half-way between the pectoral fins and the first dorsal, but a little behind this point curves some way downwards (outwards on the flattened body), nearer and nearer to the lateral edge, which it afterwards follows all the way to the middle of the base of the caudal fin. From the temples the lateral line sends out in a forward direction an occipital and a parieto-frontal branch, the latter of which, however, soon divides and sends out a supraorbital branch on the snout, while its other division, the suborbital branch, apparently disappears just below the eyes. In a downward direction from the temples runs an opercular branch, which lower down (above

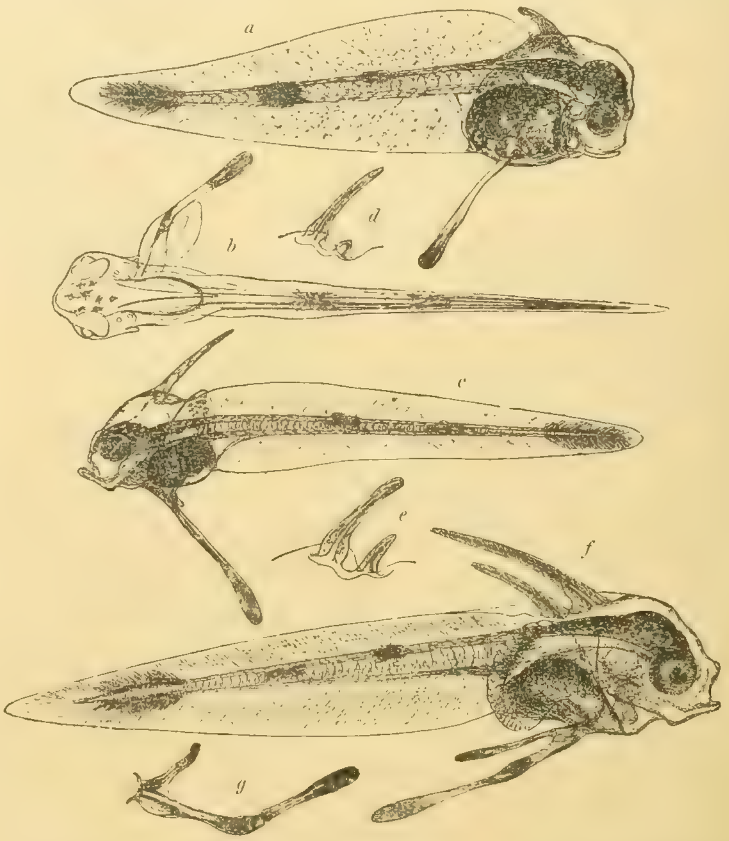

Fig. 37. Young of *Lophius piscatorius*. *a:* a specimen somewhat older than the oldest one in the preceding figure, but still with only one ray in the dorsal, as well as in the ventral fin; *b:* the same specimen seen from above, with the pectoral and ventral fins figured only on one side; *c:* a somewhat older specimen, with the rudiment of a new ray in the ventral fins, on the inner side of the first ray; *d:* rays of the dorsal fin in a somewhat older specimen; *e:* the same rays in a still older specimen; *f:* an older specimen, with the rudiment of a new ray in the dorsal fin, behind the first two; *g:* the rays of the ventral fin in a specimen somewhat older than *c*, and of about the same age as that from which fig. *e* is taken. After ALEX. AGASSIZ.

the interopercular spine) is divided into three branches, the first advancing along the cheek, the second along the lower jaw, and the third in a posterior direction on the branchiostegal membrane, to the lower margin of the base of the pectoral fins.

Thanks to the investigations of A. Agassiz[a], we now have complete information of the great changes which the form of the Angler undergoes during growth. Off Newport and in Massachusetts Bay (N. America), during the month of August, Agassiz found band-shaped, gelatinous masses floating at the surface, 2 or 3 feet broad and from 25 to 30 feet long, of a light violet-gray colour, but covered with black dots arranged in one layer. The dots are the eggs, in which the black-coloured embryos are still enclosed (fig. 36, *a*). In their first stages these embryos, or even the hatched fry, are scarcely recognisable as belonging to this species. The body is elongated, and the head no broader than in the ordinary fish-embryo. The embryonic fin-membranes of the dorsal and ventral edges — on the latter the membrane extends only behind the vent — are united at the end of the tail (diphycercal); and the comparatively thick notochord is almost perfectly straight all the way to this point. But even while the embryo is still enclosed in the membrane of the egg (fig. 36, *a* and *b*), the pectoral fins have begun to appear, in the form of dermal flaps on the sides, behind the head; and on the back, vertically above them, a protuberance rises towards the dorsal edge. From this protuberance the first ray — which subsequently becomes the second — of the dorsal fin soon rises; and simultaneously, as soon as the embryo has left the egg and before the yolk-sac is entirely absorbed (fig. 36, *c*), there appears on each side of the belly, below the base of the pectoral fin, a cauliform or somewhat clavate process, which is the rudiment of the first (outermost) soft ray in the ventral fin. This process, which for a time (fig. 37, *g*) is geniculate, grows longer and longer. On its inner side (fig. 37, *c*) there appears the rudiment of a new (inner) ray, and this new formation on the inner side is repeated once more during the growth of the rays. When the longest of them (fig. 38, *b* and *c*) is considerably longer than the whole body of the fish, the membrane of the ventral fins is also highly developed, and the rudiment of the outermost (first) ray in these fins (the spinous ray) begins to appear. Meanwhile the rays of the first dorsal fin (fig. 37, *d*, *e* and *f* and fig. 38, *a*, *b*) also increase in the same

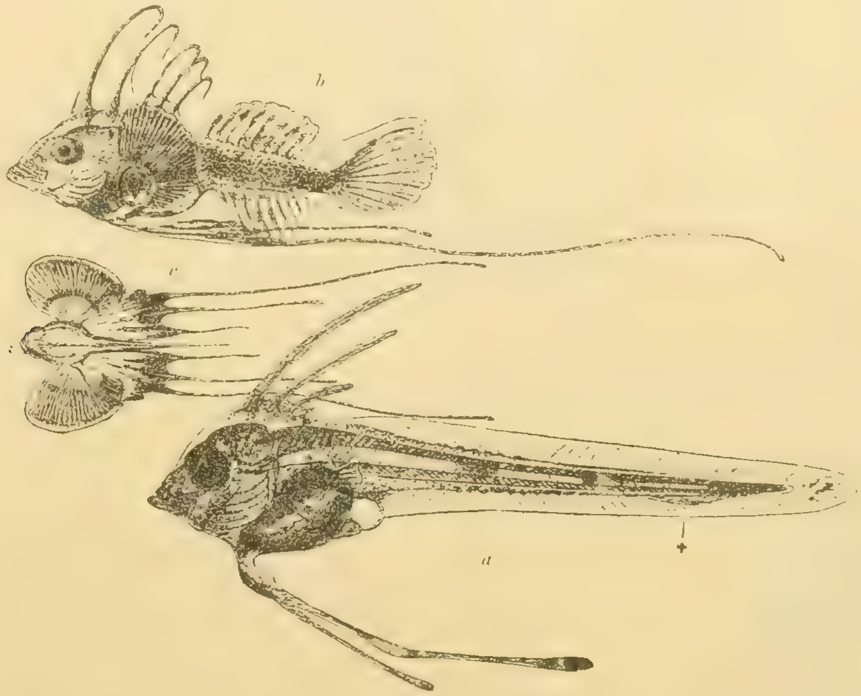

Fig. 38. Young of *Lophius piscatorius*. *a:* with 4 rays in the dorsal fin and with the rudiments of the caudal fin (+); *b:* with 6 rays in the first dorsal fin, with heterocercal caudal fin, and with the second dorsal and the anal fins almost typical in form; *c:* the same specimen, seen from above and less powerfully magnified. After Al. Agassiz.

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[a] Proc. Amer. Acad., l. c. Cf. also Baird, American Naturalist, vol. V (1871), p. 785. We have only very little information, with this exception, of the propagation of the Angler: we only know that males are rarer than females, and that Thompson estimated the number of eggs in a gravid female $4^1/_2$ feet in length to be 1,427,344 (see Day, l. c.), while Baird calculated that there were at least 432,000 in the gelatinous mass found by him.

way in number and length, though they never attain so great a length as the rays of the ventral fins. For a time all the last four rays in this fin are united by a membrane at the base (fig. 38, *b*), until at last the first ray appears just in front of the second and above the middle of the eye, being thus some distance from its future place on the snout, although the whole anterior part of the fin has advanced considerably from its original situation. The flat dermal flaps, the rudiments of the pectoral fins, have steadily grown, and been furnished with a greater number of rays; but even in the last stage examined by Agassiz (fig. 38, *c*) the tips of these rays are not yet free. Last of all appear the second dorsal and the anal fins, which occupy their ultimate situation and mutual position pretty closely from the first, and the caudal fin, the first rudiment of which appears on the ventral side of the notochord (fig. 38, *a*, +) in the form of two cartilaginous disks lying below the notochord in the mesial line of the body, the one in front of the other, just in front of the boundary of the pigment collected on the rudimentary, rod-like rays in the fin-membrane round the end of the tail. During the subsequent development of the fin these cartilaginous disks force the end of the notochord upwards; and at their lower margin, which eventually becomes the hind margin of the tail (the hypural bones), the future rays of the caudal fin begin to appear (fig. 38, *b*). This is the usual course of development of the caudal fin in the osseous fishes, the caudal fin of which is thus originally ventral, like the greater (lower) part of the caudal fin in the heterocercal fishes, and is, strictly speaking, to be assigned to the same

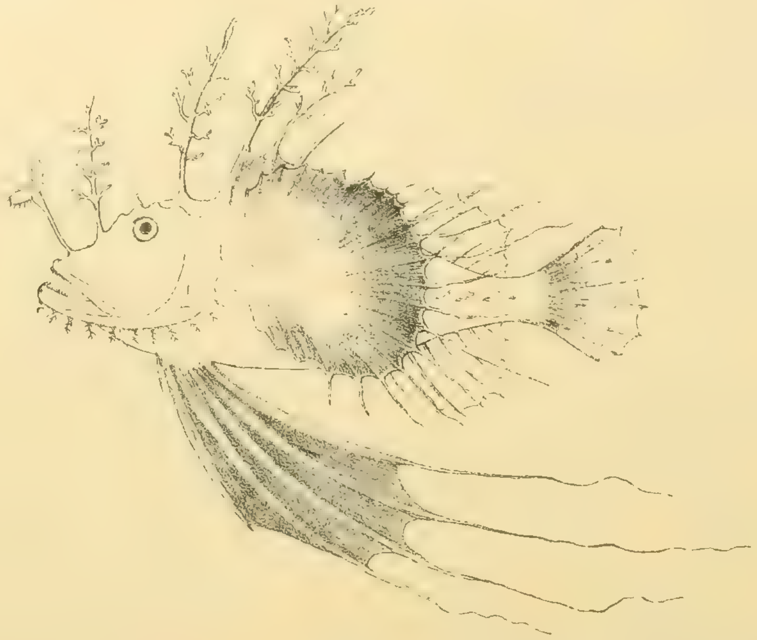

Fig. 39. Young *Lophius piscatorius* from the Mediterranean off Messina. After Rüppell and Günther.

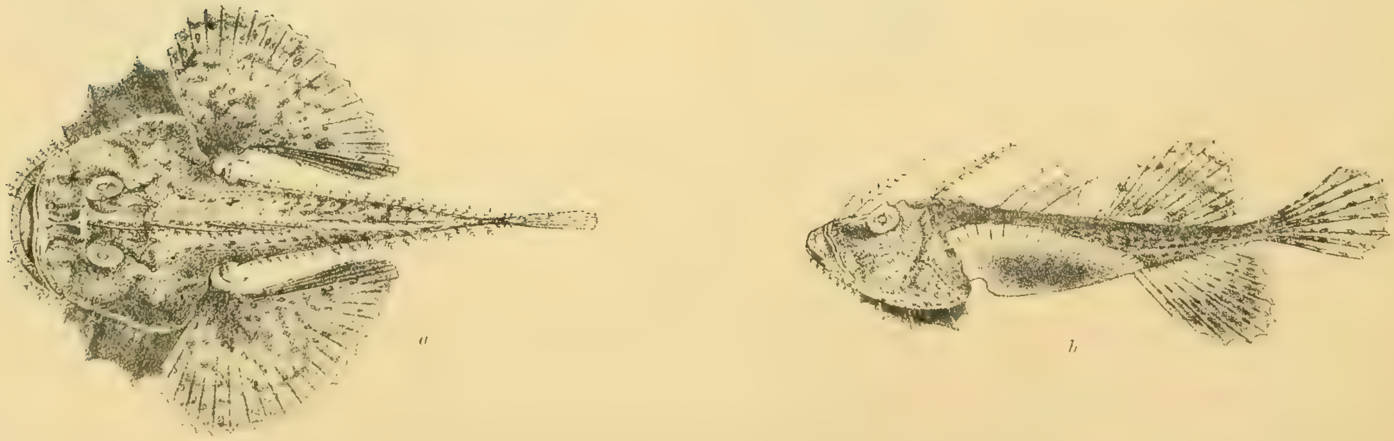

Fig. 40. Young *Lophius piscatorius* (= *Loph. eurypterus*) from Christiansund (Norway). Natural size. After v. Düben and Koren. *a*: seen from above; *b*: seen from the left.

division of the fins as the anal. In the osseous fishes, in most cases at least, only the upper supporting rays of the caudal fin are developed above the notochord (dorsally).

The last stages of development in this species which Agassiz has figured, are active young specimens which rove at the surface of the sea which was their cradle. The step from their form to the stage figured by Rüppell from a Mediterranean specimen and described by Günther[a] (fig. 39), is no very great one. At this stage the Angler with its fringes, if we compress its head laterally, as is shown in the figure, is not unlike a *Cottus* or a *Scorpæna*. The rays of the pectoral fin, like those of the ventral, are prolonged in a filiform shape beyond the margin of the fin; and the base of the latter fin is still more distinctly advanced, in front of the insertion of the pectoral fins. The first five rays of the dorsal fin have received their typical covering of filaments, and the whole of the anterior part of the dorsal fin is in its typical position; but the first rays, especially the first of all, are still comparatively short, and, most important of all, the head is considerably shorter in proportion to the length of the body at this stage than it becomes afterwards. The fin-formula now is: *D.* 1 + 1 + 1 + 3/12; *A.* 10; *P.* 23; *V.* $^{1}/_{5}$; *C.* 8. Starting from this form Günther had no difficulty in showing that *Lophius eurypterus* of v. Düben and Koren (l. c.) was a young specimen of the common Angler. The latter authors obtained their specimens from the Norwegian coast off Stavanger and Bergen and from the harbour of Christianssund, where one specimen (fig. 40) was found actively swimming at the surface, and was kept alive in a vessel for some days after it was caught — "it liked to stand upside down in the vessel, and often, too, swam on its back, rooting with its snout in the bottom". At this stage the pectoral fins have their full number of rays, which, like those of the ventral fins, have lost their long, filiform tips; but both the pectoral and the ventral fins are still so large that this larval stage may in this respect be set side by side with the largest-finned *Cottidæ*. On account of their large size the pectoral fins are folded internally (posteriorly) at right angles to the rest of the fin. The fin-formula for this stage is *D.* 1 + 1 + 1 + 3/12; *A.* 11; *P.* 27; *V.* $^{1}/_{5}$; *C.* 1 + 6 + 1.

The length of the Angler rises in ordinary cases as high as 3 or 4 feet; but it is also stated to have attained a length of even 6 feet. Its life is that of a treacherous bandit. It lies idly, but in a carefully chosen place, at the bottom of the sea, hidden among seaweeds or stones. It can probably change its coloration, which is by no means disagreeable, to suit the surroundings. Sometimes, too, it buries itself in the mud, with only the mouth and the gill-openings free. In this position it lies in ambush for its prey. Perhaps it also allures its prey by means of the mobile, anterior rays of the dorsal fin. In this case it must do so chiefly by means of the first, the double fringe of which may well be capable of imitating in its movements some small, swimming mollusk, a small fish, a worm or some other marine creature, if all the tales of the Angler's cunning mode of fishing which the ancient writers, from Aristotle onwards, have handed down to us, be founded on actual observations. In any case, it is true enough that its mouth is a sure grave for any creature which allows itself to be enticed too near the Angler, even if the victim be equal in size to its devourer. The form of its body, too, is clearly a point in favour of this assumption as to its way of life, a life requiring no special powers of swimming, which the Angler does not seem to possess. Observations have been made, however, which point to a different conclusion. Couch relates that a fisherman had hooked a Codfish and was drawing up his line, when he suddenly felt a new bite and a heavier weight on the line: this proved to be an Angler which had swallowed the Cod and was drawn up together with it into the boat, where it was only after a heavy blow on the head that it loosed its hold. A still clearer proof of its activity in pursuit of its prey is the fact that it has been seen seizing and devouring swimming-birds[b] at the surface of the water, while in its stomach have been found diving-birds[c] which had perhaps fallen victims to its voracity at the bottom of the sea. Among the tales of its attacking fishes already hooked, Couch relates that a Conger which had taken the hook on a long-line, was swallowed by an Angler, but struggled through its gill-apertures and in that situation was drawn up together with it. The Angler, like other fishes of great voracity, also swallows whatever comes in its way, however hard of digestion it may be; but its food seems really to consist of Rays, Gurnards and other bottom-fishes. In some places it is believed to have a great liking for the flesh of the Shark, and the fishermen therefore consider that it does good, and set it again at liberty, if they catch it. That it is not deserving of this reputation is, however, shown by the fact that among the fishes found in its stomach have been Herrings and Mackerel in scores.

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[a] Ann. Mag. Nat. Hist., l. c., *Introd. Stud. Fish.*, p. 471 and *Handb. Ichth.*, p. 334.

[b] *Phalacrocorax carbo*, *Larus argentatus*, *Colymbus glacialis*, *Anas penelope*.

[c] *Uria troile* and *Alca torda*.

Its way of life being of this nature the Angler is probably of solitary habits: as far as we know, at least, it has not been met with in any large number at one spot. The smaller specimens, from 2 to 3 feet in length, are found in water not more than from 15 to 18 fathoms deep, and sometimes so near shore that they are left dry at ebb tide; the larger specimens are occasionally taken at a considerable depth, from 100 to 300 fathoms, but according to Agassiz they also move into the higher regions of the ocean in summer during the spawning-season. The Angler has a geographical range which includes the Mediterranean and the Black Sea (Nordmann), and extends throughout the basin of the Atlantic from the Cape of Good Hope (*Lophius vomerinus*, Valenciennes, l. c.) to Varanger Fjord (Collett) and Iceland (Faber), as well as along the American coast, north of North Carolina at least (Jordan and Gilbert); but in Greenland it has never been found. It does not penetrate far into the Baltic, in the Sound scarcely farther north than Hven (Nilsson and Lilljeborg), but off the east coast of Schleswig-Holstein it has been caught fairly often (Möbius and Heincke). In Bohuslän the Angler, says Malm, "is not so rare as would generally seem to be the case, partly because the fisherman regards it with hatred when it is accidentally taken in the net set for other fishes, and partly because it is so feared by many that the tackle is cut as soon as the "monster" reaches the surface; and its captor hurries home in order to get there, if possible, *before the misfortune portended by the monster overtakes him*." Nilsson too, writes of the fishermen on the banks: "Among other things they believe that on board the vessel on which an Angler is taken, someone is *feg*[a], i. e. doomed to die soon. They, therefore, never or hardly ever take the Angler on board, but prefer to cut the line and thus lose the hook with the fish. Sometimes, when they have drawn it up to the surface, and when its wide mouth is open, they cast a stone, the largest a man can lift, into its throat, and thus sink it to the bottom." It is, therefore, seldom that the Angler is made use of in any way, though its flavour is said to be far from bad.

Linnæus called the Angler *hafs-padda* (= Sea-toad, *Skånska resan*, p. 327) and *grodqvabba* (= Frog-fish, *Mus. Ad. Fr.*). According to Ekström and Malm the most common name for the species in Bohuslän is *merulk* (Sea-cottus); according to Cederström and Malm it is called *hafulk* (*haf* = *mer*) in the north of Bohuslän.

Genus. **ANTENNARIUS.**

Head middle-sized, and, like the body, laterally compressed: mouth more or less perpendicular, middle-sized, or fairly large. Bones of the head without spines. Body naked or with sparse, granular papillæ or pointed spines, and most often with dermal fringes. Lower jaw, intermaxillary bones, palatine bones and the head of the vomer, as well as the upper and lower pharyngeals, furnished with cardiform teeth. Eyes set laterally. In the first dorsal fin three rays, the first two on the snout (in front of the eyes), the third on the front behind the eyes; the first tentacular with foliate tip and set just in front of the base of the second, the last two strong, spinous rays, with a more or less developed, thick fin-membrane behind them. Second dorsal fin considerably longer than the anal. Four gills; but the fourth branchial arch with no gill-slit behind it, and the first with branchial lamellæ only on its inferior part. Gill-rakers only slightly developed, verrucose. The gill-openings resemble comparatively small holes in the lower corner of the axil. Basal bones of the pectoral fins three. Ventral fins perfect. No pyloric appendages. Air-bladder present. Rays of the caudal fin 9. Posttemporal bone free, and articulating with the mastoid bone.

The compressed form of the *Antennarii* (Linnæus) causes the characters of the *Pediculati* to appear here in a singular manner. Those of these fishes that creep among seaweed and coral, look like strange quadrupeds, the ventral fins taking the place of the forelegs, and the geniculate, pectoral fins that of the hind legs. Though some of them have a hard skin, strengthened even by spines, those which are now of special interest to us, have a soft, loose skin, in extreme cases with scattered, soft, granular papillæ, and here and there, as in *Lophius*, furnished with dermal fringes, which even OSBECK[a] supposed to be intended to give the fish a resemblance to the weeds, as a protection against fishes of prey. On account of this looseness of the skin, and on account of their power of distending themselves by filling their stomach with air or cramming it with food, the form of these fishes, which is always irregular, and renders the definition of the species difficult, becomes variable to a high degree. The colouring is especially gorgeous, and in this respect some members of this genus rival the most beautiful of fishes; but here, too, is a source of difficulty in the definition of the species, for these colours are as variable and irregular as they are handsome. The genus *Antennarius* really belongs to the tropic seas; and, in spite of the uncertainty in the definition of the species, it may be assumed to include from about 20 to 30: BLEEKER assigns 24 species to the East Indian Archipelago alone. As a wandering stranger, one of these species may be included in the Scandinavian fauna.

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[a] Scotch 'fey'. Sw. *feg* properly cowardly. Tr.

ANTENNARIUS HISTRIO.

Plate X, fig. 3, and fig. 41.

Skin naked, covered with soft papillæ, with scattered fringes on the sides and more numerous ones on the belly, the lower jaw (with the corners of the mouth) and the thick, free rays of the dorsal fin. Second dorsal fin so long that its posterior rays, when laid down, extend farther back than the base of the caudal fin. Length of the ventral fins equal to that of the rays of the pectoral fins. Coloration yellowish or reddish, marbled with white spots and patches and irregular, broad, brown stripes, which form a network, and three or four of which radiate from the eye, while some cross the second dorsal and the anal fins obliquely, and others the caudal fin transversely.

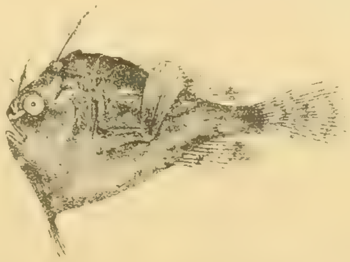

Fig. 41. *Antennarius histrio*, from Finmark. Natural size. After v. DÜBEN and KOREN

R. br. 6: *D.* 1 + 1 + 1 | 12 = 9 + 3 l. 10 + 2[b]; *A.* 7[c]: *P.* 10[d]; *V.*[e] $^1/_5$; *C.*[f] 9 = 1 + 7 + 1.

Syn. *Lophius tumidus*, LIN., *Mus. Ad. Fr.*, I, p. 56; OSB., *Ostind. Resa*, p. 305.

Lophius (*Histrio*), ODHELIUS, *Chinensia Lagerstromiana*, Disp. Ups. 1754 (LIN., *Amæn. Acad.*, vol. IV, p. 246).

Lophius histrio, p.p., LIN., *Syst. Nat.*, ed. X, tom. I, p. 237; GILL (*Pterophryne*), Proc. U. S. Nat. Mus., vol. I (1878), p. 222; JORD., GILB., *Syn. Fish. N. Amer.*, Bull. U. S. Nat. Mus., No. 16, p. 845; LILLJ. (*Antennarius*), *Sv.*, *Norg. Fisk.*, vol. I, p. 775.

Chironectes lævigatus, CUV., Mém. Mus. D'Hist. Nat., tome III, p. 423, tab. XVI et XVIII.

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[a] "Providentia fortassis hisce fulcris vestivit, ut a rapacibus piscibus confundatur cum Fuco, ne plane destruatur": OSB., *Ost. Resa*, 1750—1752, p. 305.

[b] Out of 17 specimens from St. Bartholomew I find one specimen with 3 undivided rays at the beginning of the second dorsal fin, then 1 branched (the 4th ray), next 4 undivided (the 5th—8th rays) and last 4 branched; most of the other specimens have 9 undivided and 3 branched (9 + 3) or 10 + 2, others 11 + 1 or 8 + 4 or 8 + 3 or 7 + 3.

[c] BLEEKER gives *A.* 7 or 8, only the last 5 or 6 branched. In one specimen from St. Bartholomew all these rays are divided, in the others BLEEKER's formula holds good.

[d] All simple. According to BLEEKER: *P.* 10 l. 11. Three of the specimens mentioned above have 9 rays in the pectoral fins and three 11, all the others have 10.

[e] All simple. According to BLEEKER: *V.* 5.

[f] According to BLEEKER: *C.* 1 + 7 + 1 or 1 + 5 + 3. In two of the specimens from St. Bartholomew *C.* 8 + 1, i. e. all the rays except the lowest are branched: in the others *C.* 1 + 7 + 1.

Chironectes pictus, Ch. tumidus, Ch. lævigatus, Ch. nesogallicus, Ch. marmoratus, Cuv., Val., *Hist. Nat. Poiss.*, vol. XII (de his synonymis vide Gthr, *Cat.*): *Ch. pictus*, Steenstr., Vid. Meddel. Naturh. For. Kbhvn 1863, p. 208, cett.
Chironectes arcticus, Düb., Kor., Vet.-Akad. Handl. 1844, p. 72, tab. 3, fig. 4 et 5; Nilss., *Skand. Fn., Fisk.*, p. 257.
Antennarius marmoratus, Gthr, *Cat. Brit. Mus., Fish.*, vol. III, p. 185; Coll. (forma picta), Vid. Selsk. Forh. Chr. 1874, Tillægsh. p. 69; Bleek., *Atl. Ichth.*, tome V, p. 23, tab. CXCVIII, fig. 4, tab. CXCIX, fig. 1.

Obs. As Cuvier has remarked, Linnæus's *Lophius histrio* comprehended all the species belonging to the group *Antennarius*. When Linnæus quoted Willughby in *Syst. Nat.*, he clearly referred to those species also in which the skin is covered with spines; and Günther (*Cat.*, p. 188) has given the Linnæan specific name to one of these species — Cuvier's (l. c.) *Chironectes scaber*. First among his synonyms, however, Linnæus quotes the *Wästgöta-resa* (where the great length of the pectoral fins, among other things, shows that he did not refer to *Antennarius scaber*) and *Museum Ad. Frid.*, Odhelius's thesis and last of all Osbeck's *Ostindiska resa*. Hence Gill asserts that the Linnæan specific name is most correctly applied to the species common in the Sargasso Sea of the Atlantic, an opinion fully borne out by Lilljeborg's examination of the type-specimen from Lagerström's collections, which is still preserved in the Zoological Museum of Upsala University.

According to Cuvier this species may attain a length of $8\frac{1}{2}$ in. (216 mm.), but specimens of so large a size are probably rare. The most usual length seems to be about 1 dm.[a], with a depth of 4 or 5 cm., the latter varying according to the distension of the belly. This fish, which creeps among the seaweed, where it feeds on tiny crustaceans, mollusks etc. which have the same home, occurs frequently in the Sargasso Sea (between the Azores and America), and in the West Indies is also common — the Royal Museum has received numerous specimens of this species from St. Bartholomew through Dr. A. von Goës. In the Indian Ocean and the Pacific, too, it occurs under similar conditions. It is the influence of the Gulf Stream, which has carried many other objects from the warmer parts of the Atlantic as far as the extreme north of Norway, that explains the fact that in 1826 two specimens of this species were found among the Capelins, off Vardö in the Arctic Ocean. One of these specimens, 47 mm. in length, which is preserved in Bergen Museum, has been minutely described by v. Düben and Koren under the name of *Chironectes arcticus*. Steenstrup restored it to its proper species by showing that the singular penniform appendages mentioned in the specific diagnosis of the above authors, are really parasitic crustaceans (*Pennella sagittata*), which are known to be of frequent occurrence in *Antennarius histrio*.

Since this occasion the species has never been found in Scandinavia.

COTTOMORPHI OR SCLEROPAREI.

The suborbital ring united to the preoperculum by an osseous connexion. Dorsal spinous rays strong and stiff. Ventral fins free, thoracic or jugular, often with less than 5 soft rays. Pectoral fins broad, with broad and flat basal bones. Branched rays in the caudal fin under 14. Head, as a rule, furnished with numerous spines. Jaw-teeth, where they exist, cardiform, weak and of uniform size. Comparatively few pyloric appendages. In most cases a prominent wart (genital papilla) behind the vent.

These forms are otherwise known as the *cheek-armoured fishes* ("*Acanthopterygiens à joues cuirassées*"), under which name they were first adopted by Cuvier as forming a natural whole, in the most essential respects corresponding to the three genera *Trigla, Scorpæna* and *Cottus*, which Artedi set side by side. They form a series of families with the most variable forms, from the almost typical and pure Percoid form of some Scorpænoids (*Sebastes*) to the monstrous appearance of others (*Scorpæna*) and their relatives (*Pelor, Synanceia*), where the dermal appendages are still more developed than in the preceding family, or, in another direction, to *Dactylopterus* or *Agonus*. The universal character which unites them all, the cheek-armour, is, however, by no means confined to these fishes. It also occurs both in a North Pacific family, *Heterolepidæ* (*Chiridæ*), which is remarkable in several other respects, and which is now regarded by GÜNTHER[a] as belonging to the *Blennomorphi*, and in the Gobiomorph family *Cyclopteridæ*. In the *Cottomorphi* the cheek-armour may be traced through different degrees of development, from its perfect form in the Trigloid type to the far narrower osseous bridge across the cheek in the true Cottoids.

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[a] According to Bleeker it attains a length of from 86 to 190 mm. in the Dutch East Indies.

Fam. **SCORPÆNIDÆ.**[b]

Body perciform (elongated, oval and more or less compressed) or of irregular shape, without cuirass, covered regularly with scales or naked. The spinous-rayed part of the dorsal fin longer (with more rays) than the soft-rayed part. Anal fin, as a rule, with strong spinous rays in the anterior part. Lower rays of the pectoral fins, as well as the uppermost 2 or 3, and sometimes all the rays of these fins, simple. Pseudobranchiæ, and also, as a rule, the air-bladder, well-developed.

Most of the genera within this family, including many singular forms with long dermal filaments on the body or with greatly elongated fin-rays, with the head depressed into the form of a saddle or in some other way deformed, and many of them with brilliant colours, belong to the sub-tropical and the neighbouring parts of the temperate seas, especially of the Pacific. Out of a score of recognised genera with about 200 known species altogether, only two species, each representing a distinct genus, belong to the Scandinavian fauna. These two genera, which in their extreme forms are most unlike each other, are still so nearly connected by intermediate forms that the boundary between them is, we may almost say, arbitrary. The changes of growth in the better-known of the Scandinavian species, also show that there exists a natural course of development between these genera, which starts from the true *Scorpænoids*, with fewer rays in the dorsal and anal fins, more spines on the head and a deeper depression in the forehead, and with the maxillaries naked or almost so, and passes to the almost Perciform *Sebastes*, with more fin-rays, smoother head and a closer covering of scales on the maxillaries as well as on the rest of the body. The last character is eventually developed to such a degree that in *Sebastes* and *Sebastodes*, its representative in the Pacific, small ("accessory", JORD., GILB.) scales press in between the ordinary scales of the body.

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[a] *Systematic synopsis* in Cat. Brit. Mus., Fish.; see also *Study of fishes*, p. 491; *Handb. Ichth.*, p. 350. We must remark, however, that these fishes have a large number of rays in the caudal fin and are thus distinguished from the rest of the *Anomalopteri*.

[b] GILL, Canad. Natur., Geol., n. ser., vol. II (1865), p. 247.

GENUS SEBASTES.

Body perfectly perciform. Interorbital space only slightly concave or quite level. Supraorbital spines and the ridges on the top of the head comparatively little developed. Preoperculum with 5 spines, operculum with two spinous points. Scales of the body ctenoid, thickly covering even the maxillaries. Eyes large. Dorsal fin continuous, with 15 strong, spinous rays; anal fin with 3. Cardiform teeth on the lower jaw, the intermaxillaries, the palatine bones, and the vomer. Branchiostegal rays 7. Vertebræ 30 or 31. Air-bladder present.

Thus defined, the genus *Sebastes*, originally established by CUVIER[a] with a wider extension, includes only one species, which belongs to the north of the Atlantic. KRØYER was the first[b] to point out the remarkable way in which it propagates its species. It is viviparous, the entire development of the egg proceeding in the ovaries. This peculiarity extends, however, to the near relatives of this genus, the numerous species of the North Pacific genus *Sebastodes*[c].

THE NORWAY HADDOCK (SW. KUNGSFISKEN).

SEBASTES MARINUS.

Plate IV, fig. 2 and Fig. 42.

Colouring flame-red, sometimes grayish or brownish red, on the belly paler and sometimes white, with or without large, irregular, brown spots on the gill-cover and the back. From 30 to 35 pores in the lateral line.

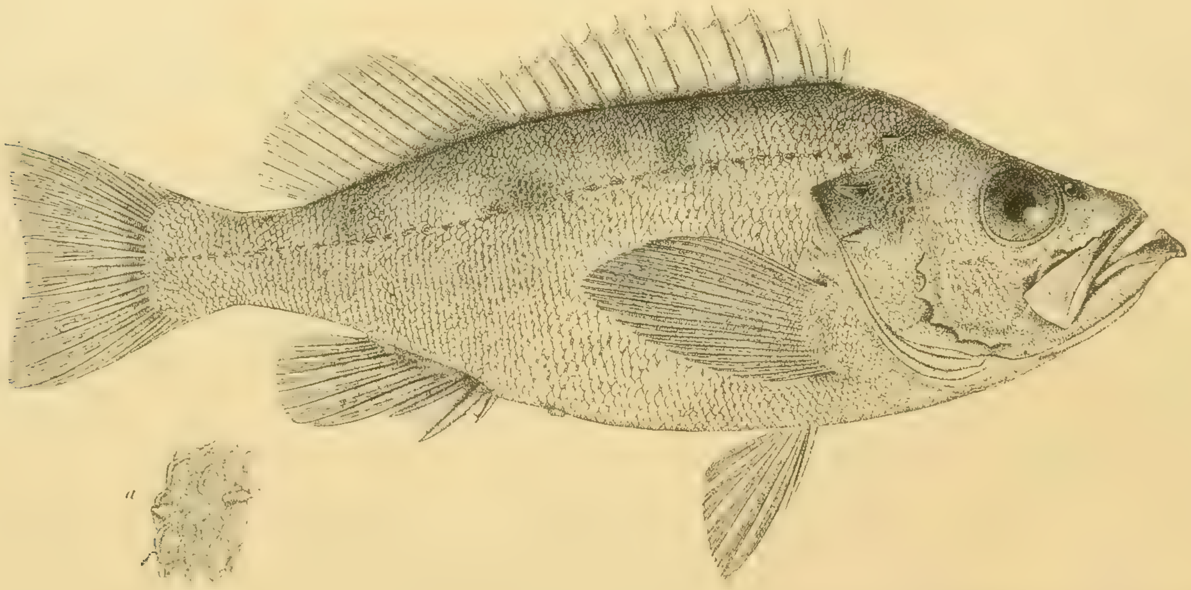

Fig. 42. Norway Haddock [*Sebastes marinus* (*norvegicus*)], found dead on the coast of Långö, near Strömstad, on the 4th of December, 1884. $^{1}/_{3}$ natural size.
a: a part of the lateral line with the adjacent ordinary and accessory scales. Full size.

Forma typica: major, boreali-arctica, *Seb. norvegicus.*

R. br. 7; *D.* 14 l. 15 $\frac{1}{13-15}$; *A.* $\frac{3}{7-9}$; *P.* 2 l. 3 + (7 l. 8 l. 9) + (7 l. 8 l. 9 l. 10) (in summ. 18—20); *V.* $^{1}/_{5}$; *C.* x + 11 l. 12 + x; *Vert.* 31.

var. minor, borealis, *Seb. viviparus.*

R. br. 7; *D.* 14 $\frac{2}{12 \text{ l. } 13^{d}}$; *A.* $\frac{3}{5-7}$; *P.* 2 l. 3 + 6 l. 7 + 8 l. 9 (in summ. 17 l. 18); *V.* $^{1}/_{5}$; *C.* x + 11 l. 12 + x; *Vert.* 30.

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[a] *Hist. Nat. Poiss.*, tome IV, p. 326.

[b] Naturh. Tidskr., Kbhvn, ser. 2, bd. 1, p. 275 and *Voy. Scand.* (GAIMARD), Pl. 6.

[c] JORD., GILB., *Syn. Fish. N. Amer.*, Bull. U. S. Nat. Mus., No. 16, p. 653.

[d] Sometimes 1 + 11 (i. e. one simple and eleven branched, soft rays), sometimes 1 + 12, and sometimes 2 + 11. Sometimes 14 according to LILLJEBORG.

Syn. *Perca marina*, Lin., *Syst. nat.*, ed. X, tom. I, p. 290 (excl. syn. Art.); *Fn. Suec.*, ed. II, p. 118; Ltkn (*Sebastes*), Vid. Meddel. Naturh. For. Kbhvn, 1876, p. 358; Malm, *Gbgs. Boh. Fn.*, p. 385; Winth., *Zool. Dan. Fiske*, p. 11, tab. II, fig. 7; Id., Naturh. Tidskr. Kbhvn, ser. III, vol. XII, p. 9; Coll., Vid. Selsk. Forh. Christ., 1879, No. 1, p. 7; Id., *Norsk. Nordh. Exped., Zoologi, Fiske*, p. 15, pl. I, fig. 3 et 4; Lillj., *Sv., Norg. Fisk.*, vol. 1, p. 92; Jord., Gilb., *Syn. Fish. N. Amer.*, Bull. U. S. Nat. Mus., No. 16 p. 651; Coll., N. Mag. Naturv., Christiania, Bd. 29 (1884), p. 52.

Perca norvegica, Ascan., *Icon. rer. nat.*, cah. II, p. 7, tab. XVI; Müll., *Prodr. Zool. Dan.*, p. 46; Fabr., *Fn. Groenl.*, p. 167; Retz., *Fn. Suec. Lin.*, p. 336; Hollberg (*Holocentrus*), *Beskr. Boh. Fisk.*, part. III, p. 49 cum fig.; Cuv., Val. (*Sebastes*), *Hist. Nat. Poiss.*, vol. IV, p. 327, tab. 87; Nilss., *Prodr. Ichth. Scand.*, p. 79; Kroy., *Danm. Fiske*, vol. I, pp. 159 et 584; Id., Naturh. Tidskr. Kbhvn, ser. 2, vol. I, p. 268; Ekstr., Vet., Vitt. Samh. Handl., Ny Tidsf., I, p. 36; Nilss., *Skand. Fn., Fisk.*, p. 91; Gthr, *Cat. Brit. Mus., Fish.*, vol. II, p. 95; Mgrn, Öfvers. Vet.-Akad. Förh. 1864, p. 508; Coll., Vid. Selsk. Forh. Christ. 1874, Tillægsh., p. 19; Day, *Fish. Gt Brit., Irel.*, vol. I, p. 42, tab. XVIII.

Sebastes viviparus, Kroy., Naturh. Tidskr. Kbhvn, ser. 2, vol. I, pp. 275 et 281; Ekstr., *Skand. Fisk.*, ed. 1, p. 197, tab. 49 (*Sebastes regulus* in tab.); Id., Vet., Vitt. Samh. Handl., l. c.; Nilss., *Skand. Fn., Fisk.*, p. 97; Kroy., *Danm. Fiske*, vol. I (Tillæg), p. 585; Id., *Voy. Scand.* (Gaimard), tab. 6; Gthr, *Cat. Brit. Mus., Fish.*, vol. II, p. 96; Gill, Proc. Acad. Nat. Sc. Philad. 1863, p. 333; Ltkn, l. c.; Cederstr., Öfvers. Vet.-Akad. Förh. 1876; N:r 1, p. 64; Malm, l. c., p. 386; Coll., Vid. Selsk. Forh. 1879, p. 9; Lillj., l. c., p. 101; Jord., Gilb. l. c., p. 652; Coll., N. Mag. Naturv., l. c.

Obs. Krøyer regarded the smaller form of *Sebastes marinus* as a distinct species, *S. viviparus*, founding his opinion chiefly on the difference in the reproduction[a], the colouring, the breadth of the interorbital space, the length of the pectoral and ventral fins, the number of rays in the dorsal and anal fins, and the number of the vertebræ. Hereto Lütken added the difference in the geographical range of the two forms — the smaller form does not occur, so far as is known, within the Arctic part of the Atlantic —; and Collett pointed out the difference in the direction of the anterior spines of the preoperculum, a remark which Lilljeborg also applied to the preorbital spines. This specific difference is indeed marked and manifold enough to be employed in most cases, but on closer examination, as Nilsson also found, it sinks into an expression of different stages of development and individual peculiarities. This is true of the direction of the first spine both on the margin of the preoperculum and on the lower margin of the preorbital bone. The changes of development in *Seb. viviparus* clearly tend to prove that the position and the direction of these spines approach more and more to those they have in the larger form, the so-called *Seb. norvegicus*. In the smallest specimens of *Seb. viviparus* in the Royal Museum, two specimens from Norway 180 mm. in length, these spines are all directed backward, the five preopercular spines being situated at fairly equal distances from each other, only the upper (posterior) ones a little closer together — almost as in our figure of *Scorpæna dactyloptera*, though the spines in the young specimens of *Seb. viviparus* are longer and more pointed — the two preorbital spines being of fairly equal size and as acutely pointed as the others. The lower part of the preoperculum is now elongated, and this bone, which was at first of a fairly regular, arcuate form, approaches more and more the form of a rounded angle. That this is due to the elongation of the lower (horizontal) part, and its growth in a forward direction, is shown just by the fact that the two lower (anterior) spines grow farther and farther distant from the three upper spines and farther and farther apart from each other: the first spine moves nearer the articulation of the lower jaw. At the same time the first spine generally grows more obtuse (assumes a broader, triangular form); and in a specimen from Strömstad, a male 207 mm. in length, the first spine of the right preoperculum is flat, triangular and directed almost straight downward, while that of the left preoperculum has the same form, but the tip of the spine points distinctly in a backward direction. The transition to *Seb. norvegicus* in this respect is, therefore, quite clear. The specimens of the Royal Museum also show similar alterations in the preorbital spines, which on the left side of a male *Seb. norvegicus* from Archangel, 228 mm. in length, are of exactly the same form and direction as on the same side of a female *Seb. viviparus* from Säcke Fjord (Strömstad), 251 mm. in length. In the large specimens of *Seb. norvegicus* we find, however, a character which we have never observed in *Seb. viviparus*, namely that the anterior margin of the posterior preorbital spine is sometimes furnished with 2 or 3 serrate teeth pointing downward. The pointing of the lower jaw in *Seb. norvegicus* by the development of a protuberance on the chin is a change of growth which in small specimens of this form, sometimes at least, is no more prominent than in large specimens of *Seb. viviparus*. The interorbital breadth in proportion to the size of the eyes is subject to far too great individual variations to be of use as a specific character. In two female specimens of *Seb. viviparus* from Bohuslän, the one 226 mm. in length, the other 251 mm., the least breadth of the interorbital space is respectively 68 % and 77 % of the longitudinal diameter of the orbit; in a male from Bohuslän, 207 mm. in length, the corresponding ratio is $63\frac{1}{2}$ %, and in a male *Seb. norvegicus* from Archangel, 228 mm. in length, 72 %. The number of rays in the dorsal, anal, and pectoral fins is generally less in *Seb. viviparus;* but a specimen of *Seb. norvegicus* in the Royal Museum has only 13 soft rays in the dorsal fin (another has 16), and 3 specimens have only 7 soft rays in the anal fin. Most specimens of *Seb. norvegicus* have 19 rays in the pectoral fins, the rest 18; while most specimens of *Seb. viviparus* have 18, the rest 17. The black spots are indeed less distinct when they appear in *Seb. norvegicus*, as is shown in our figure of this form; but a greater or less degree of distinctness in markings which are in other respects exactly similar, can scarcely constitute a specific difference. Of the specific characters given only the number of the vertebræ remains — according to both Kroyer and Malm the smaller form has only 30 vertebræ, the larger 31. But the case is the same in other fishes, e. g. in the common Herring (*Clupea harengus*), a species in which the smaller forms generally have fewer vertebræ, and in which, according to Heincke[b], the number of vertebræ varies between 51 and 58. It, therefore, seems to us most natural to regard the two forms of Sebastes as belonging to the same species, the one form, *Seb. viviparus*, which is less pelagic and more probably confined to the deep water among the islands and in the fjords, more persistently and more constantly retaining the traces of the early stages of the development of the genus from the Scorpænoid type. To the history of this question we must further add that the figure of the smaller form in the first edition of "Scandinavian Fishes" is printed under the name given to the species by FRIES, *Sebastes regulus*, while the Royal Swedish Academy of Science possesses a figure of the larger form, signed by W. v. WRIGHT and coloured under FRIES's direction in 1835, though not quite finished, which bears the name *Sebastes norvegicus*. FRIES had thus already distinguished between the two forms.

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[a] Koren, quoted by Malmgren (Öfvers. Vet.-Akad. Förh. 1867, p. 260), Lilljeborg (l. c.) and Collett (l. c.) have proved, however, that the larger form is also viviparous.

[b] *Die Varietäten des Herings*, 2:te Theil, p. 55.

The Norway Haddock, in its Arctic home at least, attains a length of 1 metre or slightly over[a]; but the smaller form, which is the more common in the fjords and the island-belt of the south of Norway and off the coast of Bohuslän, attains, to the best of our knowledge, only a third of this length. The body is compressed and, in comparison with that of the Perch, somewhat high, especially in the smaller form, where in the gravid females the greatest height of the body is about 33 % of the length, while in the males it is about 31 %. In the larger form it varies between 30 % and 28 %. The curves of the dorsal and ventral profiles are about equal: but in the female the belly is distended at the time of parturition, and the curve of the belly is then sharper than that of the back. The greatest breadth (thickness) of the body behind the head is equal to, or slightly greater or less than half the height. The back is convex, the belly almost flat. The head is fairly large, its length from the tip of the snout varying between 30 % and 33 % of the length of the body. The forehead is flat, in the smaller form somewhat concave[b]; near the occiput, where two parallel, osseous ridges occur, which slightly diverge posteriorly, it is somewhat depressed. The mouth is large and directed upwards, and admits of some protrusion of the intermaxillaries. The length of the intermaxillary bones is almost equal to the distance from the tip of the snout to the anterior margin of the pupil. The upper corner of the broad extremity of the upper jawbone extends to a point beneath the middle of the pupil, when the mouth is closed. The length of this bone varies between 82 % of the length of the lower jaw, in small specimens, and 69 %, in large ones. The prominent, lower jaw has at the point of the chin a protuberance which forms a hook turned downwards and, including the height of the teeth, in large specimens at least, is equal in height to the diameter of the pupil, or somewhat greater than it. The length of the lower jaw varies between 17 % and 18 % of the length of the body. The intermaxillary teeth anteriorly form broad bands, which posteriorly taper to a point, but are broken and separated at the tip of the snout. The bands of teeth in the lower jaw converge anteriorly, where the jaw rises into two, rounded protuberances. On the head of the vomer the band of teeth forms an angle with its point directed forward. The palatine teeth are set in two longitudinal bands, which are far apart and diverge in a downward and backward direction. The pharyngeals, six upper, which are closely united, and two lower, one on each side, are also furnished with fine teeth. The tongue is heart-shaped and smooth, with a free, narrow tip. Both nostrils on each side of the snout are round, the posterior being larger than the anterior, the margin of which is raised and posteriorly elongated into a dermal flap. They are situated nearer the eyes than the tip of the snout. The distance between the two posterior nostrils varies between 70 % and 80 % of the least breadth of the interorbital space. On the side of the snout, just outside the anterior nostril, is a muciferous pore, which is often open, and in other cases closed by a dermal flap. At the middle point of the distance between the nostrils, on each side of the snout, is a prominent spine. The eyes are large, set high, and slightly turned up in an oblique direction[c]. The longitudinal diameter of the orbit is generally more than $^2/_3$ of the length of the maxillaries; not until the specimen attains a length of 450 mm., do we find this ratio as small as from 30 % to 35 %. Above the orbit are two large spines in its margin, the one behind the other, and behind the posterior one, somewhat higher on the forehead, are two smaller spines on each side, nearer each other: all these spines point in a backward direction and are comparatively larger in young specimens than in old. Still higher up the forehead, in a line with the anterior of the two spines last mentioned, begin the lateral ridges of the top of the head, often preceded by two smaller spines. These ridges are smooth, longitudinal bars on the parietal bones, slightly diverging posteriorly and ending in a spine at the outer hind corner of these bones. The preoperculum is rounded, with 5 spines of fairly uniform size, the lowest 3, however, being broader and of a flatter, triangular shape in the larger (older) specimens. The operculum is triangular, with two flat, spinous points behind at the top corner. The suboperculum is long and narrow, lies under the lower posterior margin of the operculum, and at its juncture with the interoperculum bears a spine, which in older specimens has almost entirely vanished. At the beginning of the lateral line are two spines, which in old specimens, however, more or less completely disappear, the upper belonging to the posttemporal bone, the lower and posterior to the supraclavicular bone. The gill-rakers are of average length, set fairly close together and covered with fine teeth on the inner side.

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[a] DAY states that it attains a length of 4 ft.

[b] "Flatly concave" (NILSSON).

[c] As is generally the case with Physoclysts when suddenly drawn up from great depths, the eyes most often bulge out of their sockets, and the air-bladder, the external pressure being thus diminished, also forces the œsophagus and a portion of the stomach into the pharynx.

The body is covered with middle-sized, firmly fixed and imbricate scales, fringed at the hind margin with filiform points, which render the body rough to the touch. Between these scales are everywhere inserted the accessory scales mentioned above (see fig. 42, *a*). They are most numerous and spread over the greatest part of the body in the larger specimens. The head is also covered with scales, which towards the tip of the snout grow very small and resemble the accessory scales of the body. The lateral line, which pierces only every other, every third or every fourth scale, has from 30 to 35 pores, and runs parallel to the dorsal line and much nearer it than the ventral line, except on the tail, where it follows the mesial line of the body. The vent is situated in the male slightly in front of, in the female exactly at the beginning of, the last third of the length of the body measured from the tip of the snout to the base of the caudal fin. At its hind margin is a protuberance or wart (the genital papilla), which is considerably longer and more pointed in the male than in the female, and probably serves as a copulatory organ.

The dorsal fin begins above and slightly in front of the point of the gill-cover and occupies a part of the dorsal line which measures from 52 to 46 % of the length of the body, being generally relatively longer in small specimens. The last of its strong, spinous rays is usually distinctly longer than the last but one, and may therefore with reason be regarded as corresponding to the first ray in the second dorsal fin of those fishes, where two dorsal fins are present. The number of the soft rays varies between 13 and 16; and the first of these rays is in most cases undivided. The soft-rayed part of the fin is higher than the spinous-rayed. The pectoral fins are large and rounded at the point. They are inserted beneath the second spinous ray of the dorsal fin. Their length, which relatively diminishes with age, measures in the smaller form over 23 % and at most 27 % of the length of the body, in the larger form at most 22 % and at least 20 %. The number of rays in these fins is from 17 to 19, the larger form generally possessing the higher number. The uppermost two or three, as well as the lowest 8, 9 or 10, are undivided; the middle ones (from 6 to 9: the greater number in the larger specimens) are branched; the 9th, 10th and 11th are the longest. The ventral fins are inserted farther back than the pectoral. Their length, which undergoes the same changes due to age as that of the pectoral fins, measures in the smaller form more than 18 %, generally 19 or 20 %, of the length of the body, in the larger form from 16 to 18 %. The distance between their insertion and the beginning of the anal fin is generally greater in the female than in the male, being in the former about 30 %, in the latter about 26 %, of the length of the body. The anal fin, which begins beneath the first soft ray of the dorsal, is higher than the latter; but the length of its base is only 12 or 13 % of the length of the body. The caudal fin, the hind margin of which is slightly concave, has 11 or 12 branched rays, and at the side of these, at the top and bottom, a varying number of undivided, supporting rays, 6 at the top and 4 at the bottom being generally distinctly visible externally.

In most cases the colour of the head and the back is orange, gradually becoming lighter on the sides and shading into the white colour of the belly. On the dorsal sides, above the lateral line, are several dark, oblique spots, which vary, however, in number, shape and position, and which are generally wanting in the larger form. On the gill-cover, near the point, is an indistinct, large, black spot, which sometimes has one or two smaller spots at the lower margin. In the larger form this coloration of the gill-cover also disappears, as a rule. The fins are carnation superiorly, and paler towards the belly. The iris is bronze-coloured at the top, yellowish with a silvery lustre inferiorly, and has a fine brass-coloured ring round the pupil, which is dark-blue.

This fish is of fairly common occurrence in the island-belt of Bohuslän, where it bears the names of *Sjökock* (Sea-cook), *Käring* (Hag), and *Bergabborre*

(Rock-Perch). The smaller form, however, as we have remarked above, is the more common there, as well as off the south of Norway, as far north as Trondhjem Fjord. It is generally found at the comparatively small depth of from 20 to 60 fathoms, but sometimes at as great a depth as 150 fathoms[a]. South of Bohuslän the smaller form has never been met with, but the larger form has wandered on several occasions as far as the Sound[b]. An active fishery, which has this larger form as its object, is carried on along the whole coast of Norway, but especially in the north, where the Norway Haddock is found in deep water, though most often at a depth of from 60 to 100 fathoms. It has also been met with in the White Sea[c], off Nova Zembla, Spitzbergen, Iceland and Greenland, where the smaller form apparently does not exist, and also off Newfoundland and along the North American coast as far south as Cape Cod, whence the Royal Museum has received specimens which by certain characters range themselves between the two forms. The larger form has also been taken on a few occasions off the coasts of Scotland and Ireland. In the North Sea the species scarcely seems to be stationary.

The Norway Haddock seems generally to keep to a rocky bottom, where it lives on crustaceans, mollusks, and small fishes. It is of gregarious habits, for where the fisherman has one bite, it is generally not long before another follows; and among the Lofoden Islands, according to Collett, it is sometimes taken in hundreds in the nets set for Coalfish. According to Ekström it is caught, though seldom, on the coast of Bohuslän from April to July inclusive, and somewhat oftener at certain spots from October to December. The male is generally rarer than the female. The young ones leave the ovaries of the parent-fish during the spring-months, from April to May, or sometimes early in summer, when they are from 3 to 5 mm. in length. From the fact of his having received on several occasions during the month of May a pair of Norway Haddocks, male and female, that had been caught together, Ekström came to the conclusion that this fish is perhaps monogamous. At the end of May he obtained females with the eggs so advanced in development that not only the two black spots which mark the eyes, but also the whole embryo was visible within them. According to Krøyer the fry are so developed in July that they are able to leave the mother. At this period they are tiny, lively creatures which make their way up to the higher regions of the sea and swim about near the surface. During the Norwegian Arctic expeditions of 1877 and 1878, according to Collett, young specimens from 9 to 19 mm. in length were taken in the month of July, together with several pelagic crustaceans and young mollusks, in a surface-net, in the Arctic Ocean off Bear Island and Spitzbergen. Apparently, however, they soon return to the bottom of the sea, for in 1878, in the months of July and August, during the same expedition, specimens from 62 to 143 mm. in length were taken in Tana Fjord and the same part of the Arctic Ocean, at the bottom, where the water was from 120 to 150 fathoms deep.

In spite of its being viviparous, a circumstance which in other fishes admits of the production of only a comparatively small number of fry, the Norway Haddock is still fairly prolific. Collett estimated the number of the eggs in a female specimen of the larger form, 550 mm. in length, to be about 148,000, and in one of the smaller form, 300 mm. in length, 18,000. As Ryder[d], however, estimates the number of embryos in each ovary to be only about 1,000, it seems highly probable that only a small portion of the eggs come to maturity at the same time. The latter writer also believes he has found on the dorsal part of the inside of the ovary an abundant covering of flat, fleshy and highly vascular processes which to some extent corresponds to the maternal placenta of the higher vertebrates.

The Norway Haddock (Sw. *Kungsfisk* = Kingfish or *Rödfisk* = Redfish), which in Norway is more generally called *Ur*, is a fish of exquisite flavour, a veritable ocean delicacy. Its flesh is firm and white, and tastes very like that of the common Perch. In the island-belt of Bohuslän it is generally taken on the long-line. It is too scarce to be of any great commercial value, and is therefore most often eaten fresh by the fishermen themselves.

(Ekström, Smitt.)

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[a] Collett, N. Mag. Naturv., l. c. The Royal Museum has also received from a fisherman of Käringö, Mattson by name, a male specimen of the smaller form, which was taken at a depth of "from 75 to 150 fathoms, N. W. of Bergen".

[b] Nilsson (l. c.) gives several instances.

[c] Lieutenant H. Sandeberg brought home a specimen from Archangel to the Royal Museum.

[d] Bull. U. S. Fish. Comm., vol. VI (1866), p. 92.

GENUS SCORPÆNA.

Form of the body like that of the Perch or the Pope. Interorbital space and, in most cases, the top of the head and the occiput concave. Supraorbital spines and parietal ridges well marked. Preopercular spines, as a rule, 5, opercular 2. Scales of the body slightly ctenoid or cycloid, wanting or very small on the maxillary bones. Eyes middle-sized (even small) or large. Dorsal fin continuous, with 12 strong spinous rays[a]*, anal with 3. Cardiform teeth on the lower jaw, the intermaxillary bones, the vomer and, as a rule, on the palatine bones. Branchiostegal rays 7. Vertebræ from 24 to 26. No air-bladder.*

The true Scorpænoids belong to the shores of the tropic seas, where they live among the seaweed, which they closely resemble in appearance, both in their highly variable coloration and in the foliate dermal flaps which fringe the superior orbital margin and the lateral line on the sides of the body in particular. They sometimes bury themselves in the sand, an operation in which they are helped, according to GÜNTHER[b], by the strong and simple, lower rays of the pectoral fins. They have an evil reputation on account of the painful wounds inflicted by their spines; but they are said not to be really poisonous. The transition from these typical Scorpænoids, to which genus GÜNTHER assigns 40 species, to *Sebastes* may be traced, as we have mentioned above, through intermediate forms with scarcely a single missing link. The deep-sea fish of this genus which belongs to the Norwegian fauna, ranges itself among just these intermediate forms. It is without the naked depression on the top of the head and on the occiput, and entirely without free dermal flaps; the cheeks are densely covered with scales, and there is sometimes a narrow band of accessory scales on the maxillary bones; and the number of soft rays in the dorsal fin is greater than in the most typical Scorpænoids. For this reason POEY[c] gave the species a special generic name, *Pontinus*. In the Scandinavian fauna, however, where the number of species is so small, it may well retain its original name.

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[a] According to V. DÜBEN and KOREN *Sc. dactyloptera* sometimes, though seldom, has 13 spinous rays in the dorsal fin.

[b] *Fische der Sudsee* (Mus. Godeffr.), p. 74; *Introd. Study of Fishes*, p. 414; *Handb. Ichthyol.*, p. 291.

[c] Memorias Cuba, II (1860), p. 172 (according to JORD., GILB.).

THE BLUE-MOUTH (SW. BLÅKÄFTEN).

SCORPÆNA DACTYLOPTERA.

Fig. 43.

Interorbital space with a narrow concavity, and anteriorly naked, like the entire snout: the top of the head and the occiput between the ridges flat. No free dermal flaps on the body (except that which belongs to the hind margin of the anterior nostril). Lower jaw slightly projecting, with a small protuberance on the chin. Soft-rayed part of the dorsal fin lower than the spinous-rayed, the 3rd ray of which is the longest. Palate and pharynx, and often the top of the tongue, as well as the peritoneum, black or blue. Ground colour of the body red on the back, lighter on the sides and shading into white towards the abdominal line. From 3 to 5 light brown, transverse bands sometimes appear on the back, and brown or green spots on the body and fins.

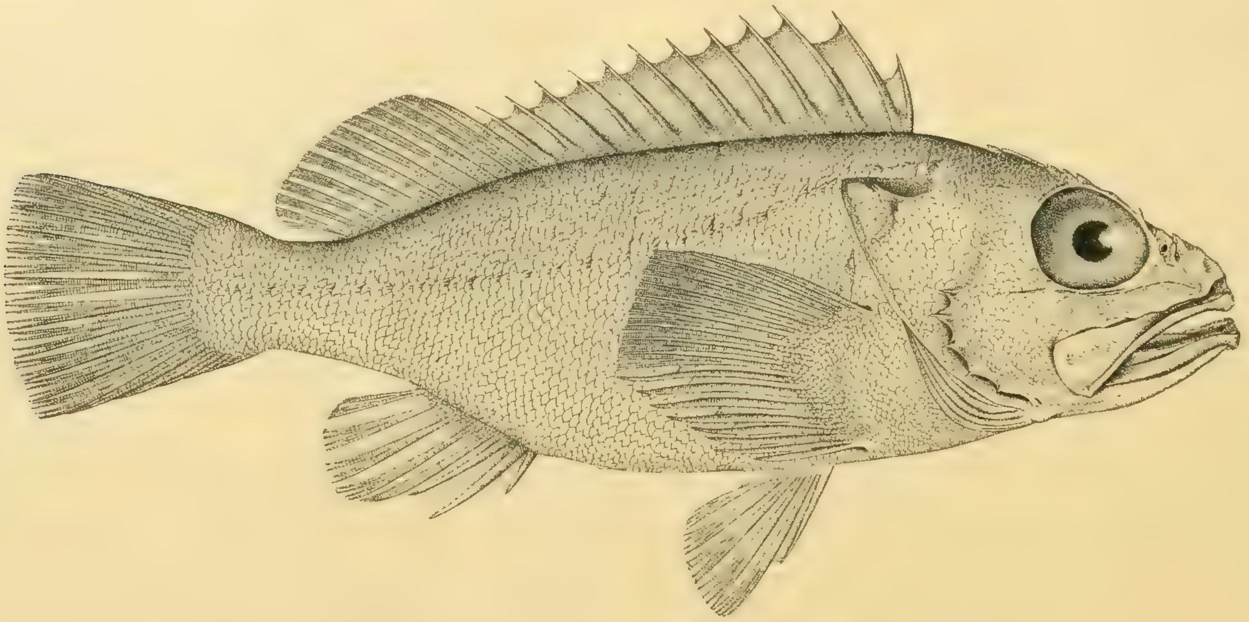

Fig. 43. Blue-mouth (*Scorpæna dactyloptera*), from Bergen. $^1/_2$ natural size.

R. br. 7; *D.* $11\ \frac{1}{1 + 11\ \text{l.}\ 12}$; *A.* $\frac{3}{5}$; *P.* 2 + 9 + 8 l. 2 + 10 + 7; *V.* $\frac{1}{5}$; *C.* $x + 11 + x$; *L. lat.* (squ. perfor.) 26—30; *Vert.* 24—26.

Syn. *Scorpæna dactyloptera*, DELAROCHE, Ann. Mus. D'Hist. Nat., vol. XIII (1809) p. 337, tab. 22, fig. 9; NILSS., (*Sebastes*) *Skand. Fn., Fisk.*, p. 100; GTHR, *Cat. Brit. Mus., Fish.*, vol. II, p. 99; STEIND., Stzber. Akad. Wiss. Wien, Math. Naturw. Cl., LVI (1867), I, p. 669; COLL., Vid. Selsk. Forh., Christ., 1874, Tillægsh., p. 19; ibid. 1879, No. 1, p. 9; LILLJ., *Sv., Norg. Fiskar*, p. 107; (?) JORD., GILB., (*Scorpæna*) Bull. U. S. Nat. Mus., No. 16, p. 679.

Sebastes imperialis, CUV., *Règne Anim.*, ed. II, p. 167; CUV., VAL., *Hist. Nat. Poiss.*, vol. IV, p. 336; KRØY., Naturh. Tidskr. Kbhvn, ser. 2, vol. 1, pp. 269 et 281; DÜB., KOR., Vet.-Akad. Handl. 1844, p. 45; (?) LOWE *Fish. Madeira*, p. 171, tab. XXIV.

Obs. As CUVIER (*Hist. Nat. Poiss.*, IV, p. 340) says that he has examined the type specimen of BLOCH-SCHNEIDER'S *Scorpæna malabarica* (*Syst. Ichth. posth.*, p. 194), which BLOCH is said to have received from ABILDGAARD, and has ascertained that it belongs to the present species, we ought perhaps to restore BLOCH'S specific name.

In LOWE'S figure to which we have referred above, the lower jaw projects very far, the dorsal line is much too convex, the jaw-teeth are large and scattered, and the maxillary bones are densely covered with scales.

It is evident that JORDAN and GILBERT'S *Scorpæna dactyloptera* from the deep water outside Chesapeake Bay can scarcely belong to this species, from the description, according to which the pectoral fin extends to a point vertically above the beginning of the anal fin, and is without the thickening of the lower rays, while the gill-rakers are described as being long.

The Blue-mouth attains a length of about 450 mm.[a]. It is distinguished in form from the Norway Haddock by the thicker (somewhat terete) head and the lower body with a less convex dorsal line. The greatest depth of the body is about 27 % of the length[a]. The least depth, on the other hand, is greater in the Blue-mouth. In a specimen of this species 352 mm. long the least depth of the tail is 9 % of the length of the body, while in *Sebastes* we have never known it to exceed $8^1/_2$ %. The length of the head is also greater than in the Norway Haddock, being about 34 % of the length of the body[b]. The eyes of the Blue-mouth, too, are comparatively larger — even in specimens 350 mm. long the longitudinal diameter of the orbit is about 10 % of the length of the body, a relation which seems to cease in the Norway Haddock at a length of about 225 mm. The dorsal fin is relatively of the same length in both species; but in the Blue-mouth the spinous-rayed part is higher and comparatively shorter. The caudal fin is perfectly truncate or rounded. The pectoral fins with their singular form — superiorly truncate at the point — are considerably broader at the base than in the preceding species, and their simple, lower rays are thicker and to a great extent free at the top, "fingerlike", a circumstance from which the species derives its name (*dactyloptera*). The length of the belly (the distance from the front point in the base of the ventral fins to the beginning of the anal fin) is less in this species than in the preceding one, being under $^1/_4$ of the length of the body. This is shown more clearly by comparison with the least depth of the body or the length of the lower jaw, both of which are greater in the Blue-mouth, the former being more than $^1/_3$, the latter more than $^3/_4$, of the length of the belly.

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[a] 17 Austrian in. (about 17 $^1/_2$ Eng. in.), according to STEINDACHNER, l. c.

The connexion between the suborbital ring and the preoperculum is much more marked in the Blue-mouth than in the Norway Haddock. This "osseous bridge" runs externally across the cheek in the form of a sharp ridge, which is anteriorly continued on the surface of the preorbital bone. The superior ridges and spines of the head are also more strongly defined in the Blue-mouth. The least breadth of the interorbital space in middle-sized specimens, about 350 mm. in length, is only about 12 % of the length of the head and 42 % of the longitudinal diameter of the orbit. In this narrow interorbital space runs a deep, longitudinal groove, coasted by two frontal ridges, which in the preceding species are only rudimentary; and between the latter and the raised, upper margin of the orbit runs another groove on each side. In each of these two lateral grooves lies a cranial branch of the lateral line, with an orifice, which is sometimes open, above the anterior nostril and nearer the middle of the forehead than it, while a similar muciferous pore, the orifice of the branch of the system of the lateral line which belongs to the inferior orbital margin, appears outside and below the anterior nostril[c].

The scales are of the same structure as in *Sebastes*, with fine spines at the hind margin, and within these a pretty, retiform brim, formed of the roots of pre-existent, marginal spines; but the accessory scales are entirely wanting in this species.

The lateral line slopes fairly evenly down from the temples, but never descends so low as the middle of the side.

The geographical range is remarkable in one respect, though this may be explained by the variations in the depth of the Atlantic. The Blue-mouth is a Mediterranean fish, by no means rare off Nice and in those parts of the Mediterranean where hooks are used for deep-sea fishing, and it is also known off the south of Portugal, the Canary Islands and Madeira; but north of Portugal it has never been found south of Norway, where it occurs at depths varying from 100 to 300 fathoms, from Stavanger north along the whole coast. It is most often taken off Bergen, where it is met with all the year round. It was from here that the specimens were obtained which enabled v. DÜBEN and KOREN in 1844 to claim and describe it as a Scandinavian species; but as far north as Tromsö, according to COLLETT, it is so common that it is sometimes caught "by the barrel". It is well known, say v. DÜBEN and KOREN, to most of the Bergen fishermen by the name of *Skär-aur* (*ur*)[d] or *Blåkäft*, the latter name corresponding to *Boca-negra* (Black-mouth), the name by which it is known in Madeira. According to LOWE its flesh is of little value, being both flabby and tasteless. According to LILLJEBORG its flavour is not so good as that of the Norway Haddock.

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[a] In one of the largest specimens (about 440 mm. in length) STEINDACHNER, however, found the greatest depth of the body to be only 25 % of the length.

[b] According to STEINDACHNER, however, the length of the head varies between 31 % and 33 % of that of the body.

[c] Cf. the preceding species.

[d] = Rock-ur, cf. the preceding species.

FAM. COTTIDÆ.

Body of the typical Cottus-form (the head thickest and the body conically pointed posteriorly), without cuirass most often naked or partly covered with plates or spines. Spinous-rayed part of the dorsal fin shorter (with fewer rays) than the soft-rayed part. No spinous rays in the anal fin[a]. *By far the greater part of the rays of the pectoral fins, as a rule, simple. Pseudobranchiæ present. Vertebræ generally more than 30.*

SUBFAMILY COTTINÆ.

Head more or less completely armed with spines, but not cuirassed. No air-bladder.

In the fauna of the northern seas the true *Cotti* and their nearest relatives are among the most prominent fishes, and their typical form is, therefore, most probably well known to most of my readers. "A head which is large in proportion to the rest of the body, sharply rounded at the top and armed with spines or protuberances, and which through the dilatation of the gill-cover and the branchiostegal membrane may undergo considerable lateral extension and assume a more depressed form; and a body which is rounded and tapers posteriorly in a conical form, is covered by a naked or spinous, highly mucous skin, and bears large, rounded fins — these are the general characters which give these fishes an easily recognisable, though uninviting appearance". Many of them, though not those forms which are common among us, have ciliate scales, scattered or even imbricate; but in far the greater number of cases the above description of EKSTRÖM holds good.

The spinous equipment of the head conforms to the same type as in the preceding family, though it is generally more highly developed. A pair of nasal spines are almost always present; and on the posterior part of the head, from the forehead to the end of the occiput, is a quadrilateral or harp-shaped patch, which is often concave and is bounded at its four corners by the so called parietal spines. The spines of the margin of the preoperculum are as a rule four in number; the operculum and interoperculum are generally armed with spines at the hind upper corner, and the suboperculum at the lower corner. As a rule, too, the clavicular and supraclavicular bones are furnished with spines at the top. The system of the lateral line is generally well-developed in these fishes, both on the head and on the body — in the former region it is most developed in the Four-horned Cottus — and on the body there are usually distinct lateral branches of the lateral line proper, but apparently[b] the system is here developed posteriorly only at an advanced age, and often enough the hind portion of the lateral line is partly incomplete or even totally wanting on the posterior half of the sides.

Another distinctive point in the *Cottidæ* is the external difference of sex, which is most often sharply marked[c]. Besides the fact that the females are usually more numerous and larger than the males, the latter, at least when full-grown, generally have a genital papilla at the vent; more marked spinous warts on the skin and more highly developed spines on the inside of the rays of the pectoral and ventral fins, the latter of which are most often elongated; higher dorsal fins; and a different coloration, often spotted with white.

The centre of the geographical distribution of the *Cottidæ* — if we disregard their scaly representatives in India and Australia — lies in the Arctic and Boreal seas: some species, too, are circumpolar. They really belong to water of moderate depth where the bottom is overgrown with seaweed; but some peculiar forms make their way to the abysses of the ocean, while others have become fresh-water fishes, the former (*Cottunculus*) presenting a certain likeness to *Liparis* and the latter (the subgenus *Uranidea*) to *Gobius*.

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[a] Of the first ray in the anal fin of *Hemilepidotus trachurus*, from Kamtchatka CUV., VAL. (*Hist. Nat. Poiss.*, vol. IV, p. 278) say that it may possibly be a spinous ray ("pourrait être épineux"), but in specimens from Behring Island it is distinctly articulated.

[b] Cf. COLLETT, *Norges Fiske*, Vid. Selsk. Forh. Christ. 1874, Tillægsh., p. 25.

[c] Cf. LÜTKEN, Vid. Medd. Naturh. For. Kbhvn 1876, p. 387.

JORDAN and GILBERT estimate the number of species within this subfamily at about 150, distributed among about 40 genera and subgenera. Those genera which belong to the Scandinavian fauna, may be distinguished as follows:

A: One continuous dorsal fin Genus *Cottunculus*.
B: Two distinct dorsal fins:
  1: Less than 20 rays in the anal fin:
    a: Palatine bones toothless:
      aa: Vomer toothless: ... Genus *Gymnocanthus*.
      bb: .. with teeth: . .. *Cottus*.
    b: Palatine bones with teeth: .. *Centridermichthys*.
  2: More than 20 rays in the anal fin: .. *Triglops*.

GENUS COTTUNCULUS.

Weak, flexible spinous rays, wrapped in a loose skin, form the anterior, lower part of the continuous dorsal fin. Skin without true scales, but granulated or rough with small spines. Head large. The four preopercular spines obtuse, and covered with skin. Fine, cardiform teeth on the lower jaw, the intermaxillary bones and the vomer. Branchiostegal membranes united to the broad isthmus, which is without any transverse fold. No gill-slit behind the fourth branchial arch.

We assign the first place among the Scandinavian Cottoids to this genus, which is without doubt the most marked metamorphosis of the Cottoid type among the forms of which we have to treat. It was first remarked and characterized as a distinct genus by COLLETT in 1874. Its metamorphosis is connected, however, in several respects with a retention of the juvenile characters of the type. It is one of these characters that most distinctly marks the genus, namely, the confluence of the two dorsal fins, or, more strictly, their retention of this condition. They are united in the same way, and with almost the same relations to each other in respect of size, or at least of height, in the most developed young specimen of *Cottus scorpius* (fig. 44) which AGASSIZ has figured[a].

Another juvenile character may be found, as COLLETT has remarked, in the coloration of the Scandinavian species, with its sharply defined, black, transverse bands on the head, body and fins. The close proximity of this genus to *Cottus* in other respects is best shown by the typical (quadrangular) arrangement of the parietal spines, the anterior pair of which are, however, situated on the forehead in a line with the hind margin of the eye.

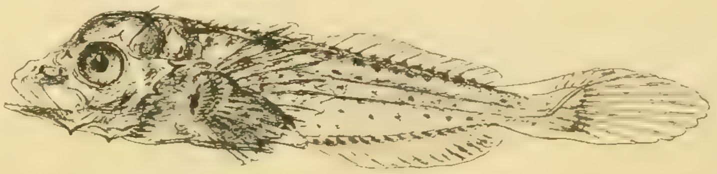

Fig. 44. A young specimen of *Cottus scorpius*, $11\frac{1}{2}$ mm. in length. Magnified. After A. AGASSIZ.

Three, perhaps four, species of this genus[b] are known to exist in the deep water in the north of the Atlantic. Only one of these species belongs to the Scandinavian fauna.

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[a] Proc. Amer. Acad. Arts. Sc., vol. XVII, *Young Osseous Fishes*, pl. II, fig. 2. The same changes of development in the mutual relations of the two dorsal fins are shown in the result of SUNDEVALL's observations of the development of *Cottus gobio* (Vet. Akad. Handl., vol. I 1855), *Om fiskyngels utveckling*, p. 7, pl. I, figs. 3 and 4.

[b] *Cottus thomsonii* GTHR. Proc. Roy. Soc. Edinb. vol. XI (1881—82) p. 679. *Cottunculus torvus*, GOODE, Proc. U. S. Nat. Mus. 1880, p. 479; JORD., GILB., Bull. U. S. Nat. Mus., No. 16, p. 688.

THE SMALL-EYED COTTUNCULUS (SW. PADDULKEN[a]).

COTTUNCULUS MICROPS.

Fig. 45.

Skin rough with scattered small spines set in groups or in small transverse rows, or isolated. Length of the head, in adult specimens, from 35 to 37 % and its depth at the occiput from 23 to 26 % of the length of the body. Eyes small, their longitudinal diameter being in adult specimens about half the breadth of the interorbital space; and closely covered to the margin of the iris by the rough skin. The tubular, anterior nostril, with its margin posteriorly elongated, is situated at a distance in front of the eye about equal to the diameter of the pupil; the posterior is less raised, and set closer to the eye than to the anterior nostril, but also a little nearer the middle line of the snout. Rays of the anal fin less than 11. Three rays in the ventral fins. The lateral line of the body opens into a row of about 15 scattered pores, of which at least the anterior are set at the top of verrucose protuberances. That part of the system of the lateral line which belongs to the head, has large open pores under the margin of the preoperculum and the lower margin of the preorbital bone (on the dermal flap above the maxillary bones). The rent is situated in adult specimens about half-way between the insertion of the ventral fins and the beginning of the anal. The anal region (in the male during the spawning-season) swollen into a large, conical papilla. Coloration grayish-white, with large, black spots, which resemble transverse bands, and are here and there interrupted by or mingled with round spots of the ground-colour.

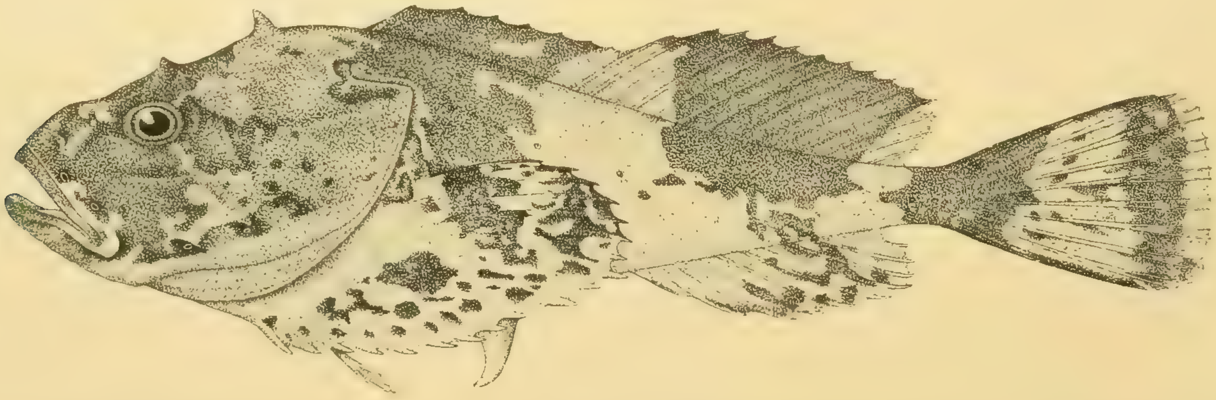

Fig. 45. *Cottunculus microps*, ♂, natural size. Taken on the east coast of Greenland, 65° 30′ N., at a depth of 130 fathoms.

R. br. 6; *D.* $\frac{6-8}{13-15}$; *A.* 10; *P.* 17—20; *V.* 3; *C.* $x+6+x$; L. lat. (por.) 10—18.

Syn. *Cottunculus microps*, Coll., Vid. Selsk. Forh. Crist. 1874, Tillægsh., p. 20, tab. 1, fig. 1—3; ibid. 1878, Nó. 14, p. 20; ibid. 1879, No. 1, p. 11; Id., *Norsk. Nordh. Exped.*, *Zool.*, *Fiske*, p. 18; Lillj., *Sv.*, *Norg. Fisk.*, vol. I, p. 113; — (?) Jord., Gilb., Bull. U. S. Nat. Mus., No. 16, p. 688 —; Coll. N. Mag. Naturv., Bd. 29 (1884), Heft. 1, p. 53.

Obs. The large eyes ("equal to the snout") and the large number of soft rays (19) in the dorsal fin render it extremely doubtful whether the specimen taken off Rhode Island and described by Jordan and Gilbert (l. c.), belongs to this species.

The Small-eyed Cottunculus seems to be a true Arctic form, though, according to Günther[c], it was found by the English "Knight Errant" Expedition of 1880, in the cold bottom-water between Scotland and the Faroe Islands, at a depth of 540 fathoms. It had previously been found by Professor G. O. Sars at a depth of 200 fathoms, off Hasvig, near Hammerfest, and by the Norwegian Arctic Expedition between Norway and Bear Island, and also west of the Norway Islands (the north-west of Spitzbergen), on a clayey bottom, at depths varying from about 200 to 450 fathoms. A fairly large number of specimens have also been taken in Trondhjem Fjord, at depths varying from 100 to 200 fathoms. During NORDENSKIÖLD'S Expedition of 1883 a male 157 mm. in length, with a large genital papilla, was taken on the 6th of September, off the east coast of Greenland, 65° 30′ N., on a clayey bottom and at a depth of 130 fathoms.

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[a] Lilljeborg, l. c.

[b] About 10, according to Collett. In the specimen belonging to the Royal Museum, we find 18.

[c] Proc. Roy. Soc. Edinb., vol. XI (1881—82), p. 679.

As COLLETT has remarked, the broad pectoral fins, with their rays, which are thick and free at the tips, especially the lower ones, are without doubt of great service to this fish. By their help it digs up the soft clay of the bottom and flounders along, preying on the worms or small mollusks and crustaceans which live in its company at a depth of 100 fathoms or still more. We have no further knowledge of its manner of life; and it can be of special interest to us only in a systematical and zoogeographical respect.

GENUS **GYMNOCANTHUS**.

Two distinct dorsal fins. Skin without scales. Head of average size (less than $^1/_3$ of the length of the body). Four, pointed, preopercular spines, the uppermost of which is furnished with from 1 to 5 lateral spines directed upwards. Palatine bones and vomer toothless. Branchiostegal membranes united to the isthmus throughout the greater part of its length, but their margin continued in a free dermal fold over its surface. No gill-slit behind the fourth branchial arch. Base of the anal fin longer than that of the second dorsal. Rays in the anal fin less than 20.

This genus is as truly Arctic as the former, if not more so, but it belongs to the littoral fauna. It was first formed by SWAINSON[a] in 1839, but from KROYER[b], in 1845, it received a new name, *Phobetor*, by which it has been better known since that time. Though its most remarkable character consists in the absence of teeth on the palatine bones and the vomer, the two species which belong to it, may be recognised most easily, within the Scandinavian fauna, by the singular form of the uppermost preopercular spine.

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[a] *Nat. Hist. Fish. Amph. Rept.*, II. pp. 181 and 271.

[b] Naturh. Tidskr., 2:den Række, 1:ste Bind. p. 263.

THE BRANCH-SPINED COTTUS (SW. GRENTAGGIGA ULKEN[a]).

GYMNOCANTHUS VENTRALIS.

Fig. 46.

No parietal spines, if we except a protuberance on each side of the hind part of the supraorbital margin: but the top of the head, sometimes from the anterior margin of the eye, and the temporal region, sometimes even the operculum and the bony ridge of the cheek, more or less closely studded with spinous warts, or at least granulated with spinous tubercles[b]. *Length of the head less than 28 % of that of the body*[c]. *Length of the maxillary bones more than 33 % of that of the head, even in the males*[c]. *Distance from the beginning of the first dorsal fin to that of the second more than 20 % of the length of the body or than 65 %*[c] *of the length of the head; and the length of the base of the second dorsal fin more than 89 % of the length of the head. Least breadth of the interorbital space less than 53 % of the least depth of the tail. Length of the ventral fins, even in the males when ready to spawn, scarcely more than 22 % of the length of the body, or hardly more than a fifth greater than the distance from the insertion of these fins to the beginning of the anal fin. Coloration brownish gray, or still darker, on the back; white or yellowish with white spots on the belly; sides marked with dark transverse bands or with high and low spots alternately; dorsal and pectoral fins with alternate dark (black or brown) and white transverse bands: ventral and anal fins of the same colour as the belly and without spots.*

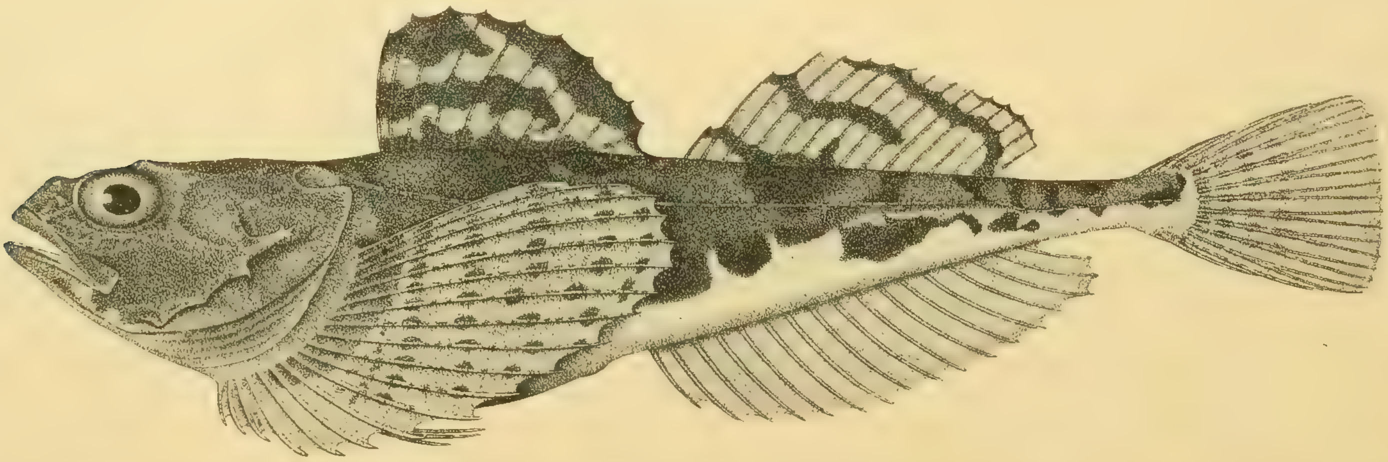

Fig. 46. *Gymnocanthus ventralis*. ♀, from Mossel Bay (Spitzbergen), taken on a rocky bottom at a depth of between $2^1/_2$ and 5 fathoms, on the 2nd of December, 1872. Natural size.

R. br. 6; *D.* 10 l. 11 (12) 15–17; *A.* 16—18 (19); *P.* 18 l. 19; *V.* $^1/_3$; *C.* x+(7 l. 8) 9+x; *L. lat.* (por.) 40—50.

Syn. *Cottus gobio*, FABR., *Fn. Groenl.*, p. 159 (vide REINHARDT).

Cottus ventralis, CUV., VAL., *Hist. Nat. Poiss.*, vol. IV, p. 194, tab. 79, fig. 1; SWAINS., (*Gymnocanthus*) l. c., p. 271; GTHR, (*Cottus*) *Cat. Brit. Mus., Fish.*, vol. II, p. 168; MGRN, (*Phobetor*), Öfvers. Vet.-Akad. Förh. 1867, p. 259; COLL., Vid. Selsk. Forh. Christ. 1874, Tillægsh., p. 30; 1878, No. 14, p. 15; LÜTK., Vid. Meddel. Naturh. For. Kbhvn 1876, p. 363.

Cottus tricuspis, REINH., Vid. Selsk. Naturv. Math. Afh. Kbhvn, Deel V (1832) Overs., p. LII; ibid., Deel. VII (1838), p. 117; KR., (*Phobetor*), Naturh. Tidskr. Kbhvn, 2:den Række, vol. I, p. 263; LILLJ. (*Cottus*), Vet.-Akad. Handl. 1850, p. 309; NILSS., *Skand. Fn., Fisk.*, p. 78; GTHR, *Cat.*, l. c.; MALMGR. (*Phobetor*), *Finl. Fisk.* (Disp. 1863), p. 11; ID., Öfvers. Vet.-Akad. Förh. 1864, No. 10, p. 504.

Cottus pistilliger, LÜTK., l. c., p. 364 (nec PALL.); BEAN (*Gymnacanthus*) Bull. U. S. Nat. Mus., No. 15, p. 127; COLL., Norsk. Nordh. Exped., Zool,, Fiske, p. 26; LILLJ. (*Phobetor*), *Sv., Norg. Fisk.*, vol. I, p. 118.

Acanthocottus patris, STORER, Bost. Journ. Nat. Hist., vol. VI, p. 250, tab. VII, fig. 2.

Gymnacanthus galeatus, BEAN, Proc. U. S. Nat. Mus., vol. IV (1881), p. 153.

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[a] LILLJEBORG, l. c.

[b] During youth — in specimens less than 50 mm. in length — this character is, however, in most cases not yet developed.

[c] The same remark applies to this character as to the preceding one.

Obs. Lütken's opinion that *Cottus pistilliger*, as described by Pallas (*Zoogr. Ross. Asiat.*, vol. III, p. 143), is identical with *Gymnocanthus ventralis*, has indeed won general approval, as appears from the above list of synonyms; but the collections made by the Vega Expedition in the north-east of Siberia seem to us to throw a new light on the question. Especially worthy of notice are a pair, ♂ and ♀, of the typical *pistilliger*, obtained off Najtschkaj. The male (fig. 47) is 163 mm. in length, has a long and pointed urogenital papilla, and is furnished with well-developed spines on the inside of both the pectoral and the ventral fins. On the part of the abdominal sides which is covered by the pectoral fins, we find the usual white spots and also the clapper-like or spatulate, soft, dermal appendages[a], with black stalk and white head, which are especially remarked by Pallas. The female (fig. 48), which is of almost the same size, is naturally without these characters. The most marked character of the species, however, is the almost entire absence of the spinous warts on the head, while on the top of the head and the occiput there are distinct, though small, spines, which correspond to the parieto-occipital spines so common in other Cottoids, in their characteristic, quadrangular arrangement. There are also several other differences from the characters we have given above in the diagnosis of *Gymnocanthus ventralis*. Considering that we have been able to compare a fully developed male of *Gymn. pistilliger*, which was ready to spawn, with a male of *Gymn. ventralis* 190 mm. in length, from Disco (Greenland), these differences seem far too great to fall under the head of variations within one and the same species. The length of the head in the former specimen is 28·2 % of the length of the body, while in the male specimen of *Gymn. ventralis* from Disco it is 26·3 %, and in a specimen of *Gymn. ventralis* 43 mm. in length 27·9 %. In the female specimen of *Gymn. pistilliger* it is 30 %. The length of the maxillary bones in the male specimen of *Gymn. pistilliger* is only 30·4 % of the length of the head, in the female

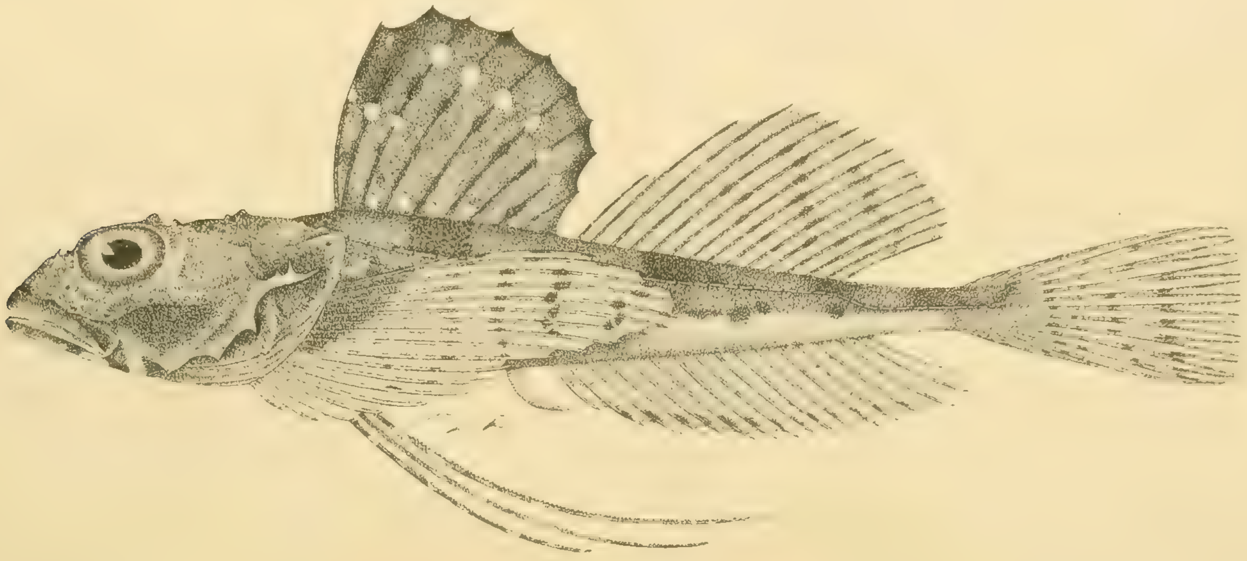

Fig. 47. *Gymnocanthus pistilliger*, ♂, with three dermal appendages (which may be seen between the urogenital papilla and the ventral fin), taken from the part of the side which is hidden by the pectoral fin. Natural size. From Najtschkaj Lagoon, 19th March, 1879.

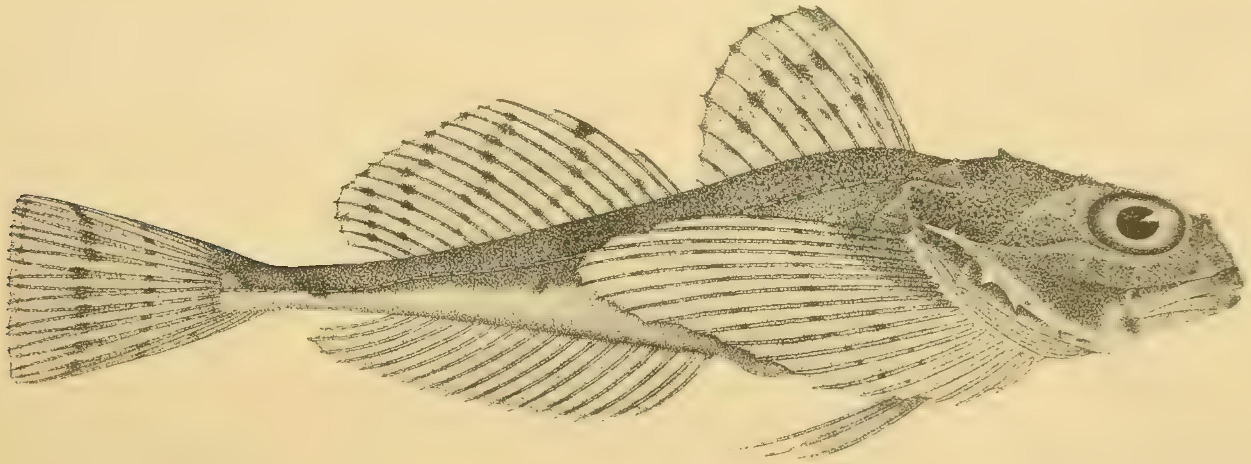

Fig. 48. *Gymnocanthus pistilliger*, ♀. From Najtschkaj Lagoon, 14th May, 1879. Natural size.

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[a] "Pedunculi pistilliformes, minuti, albi, molles, e filo brevissimo et capitulo plano fungiformi compositi" (Pallas), not as Lütken supposes, "half-cruciform, spinous scales".

30·9 %, while in *Gymn. ventralis* it is at least 33 %. The distance from the beginning of the first dorsal fin to that of the second in the first-mentioned specimen is 19·3 % of the length of the body and 64·5 % of that of the head, and in the female specimen of *Gymn. pistilliger* 18·9 % and 62·6 % respectively; while in the male specimen of *Gymn. ventralis* it is 21·8 % of the length of the body and 83 % of that of the head, and, even in the specimen 43 mm. long, 66 % of the length of the head. The base of the second dorsal fin in the male specimen of *Gymn. pistilliger* measures 82·6 % of the length of the head, in the female 84·8 %: in *Gymn. ventralis* this ratio may vary between 89 and 105 %. The least breadth of the interorbital space in the male specimen of *Gymn. pistilliger* measures 66·7 % of the least depth of the tail, and in the female 80·6 %, while in the male the length of the rays of the ventral fins, the free part of which measures about $^2/_3$ of their whole length, is 38 % of the length of the body. With the exception of the last two characters and the singular dermal appendages, the other characters of *Gymn. pistilliger*, however, indicate a retention, in common with *Gymn. ventralis*, of juvenile characters, a point which shows that these species are very closely related. It is, therefore, natural that the young specimens and the fry of both species should present a still greater similarity in their characters. Thus, a male of *Gymn. pistilliger*, 66 mm. in length, from Kara Sea, has a granulation on the top of the head which is harder than the slight trace thereof which occurs in the above-mentioned older specimens of that species, and a specimen 48 mm. in length, from the winter-quarters of the Vega Expedition, has an exceptionally small head, measuring only 26 % of the length of the body, while the length of the maxillary bones is 34 % of the length ot the head. In every case, however, the other characters should be sufficient to decide the species. The coloration of the two species seems to be the same on the whole; but in the male of *Gymn. pistilliger* the first dorsal fin is blacker, with more distinct, round, white spots in one row along the superior margin, in another shorter one at the middle of the fin, and in a third along the base, while the ventral fins have distinct, black, transverse bands. All these points, however, may sometimes be observed, though never so distinctly, in male specimens of *Gymn. ventralis*. Whether *Gymnocanthus pistilliger* occurs in the basin of the Atlantic, west of Nova Zembla, is a point on which we have no information.

Gymnocanthus ventralis is an arctic and circumpolar species. It is of fairly common occurrence off Spitzbergen, where it has been found by all the Swedish expeditions since 1837 (Sv. Lovén), among the algæ at depths sometimes as great as about 20 fathoms or even more[a]. It is met with in similar places on the coasts of Greenland and Siberia. Since Lilljeborg found it in 1848 off Schuretskaja (Russian Finmark), it has also been met with a few times off the extreme north of Norway. In 1850 a specimen from Hammerfest was forwarded to the Royal Museum by Mr. Bull. In these regions, according to Esmark[b], it lives at as great a depth as 76 fathoms, or far below the belt of marine vegetation. It attains a size of from 215[c] to 250[d] mm. Its food, in all probability, is chiefly composed of worms; but certain crustaceans (*Gammaridæ* and *Idotheæ*) have also been found in its stomach by Collett. Fabricius states, assuming that his observations refer to this species, that in Greenland it lives on a sandy or clayey bottom, even where there is no vegetation; that it is more cautious and quicker in its movements than the true *Cotti*: and that the female lays its eggs among the ulvæ, while the male is supposed to keep guard over them until they are hatched.

Genus CENTRIDERMICHTHYS.

Two distinct dorsal fins. Skin naked or with spines or scales. Head middle-sized. Uppermost preopercular spine bent or branched or with lateral spines. Palatine bones and vomer with teeth. Branchiostegal membranes united, with a free transverse fold under the isthmus. No gill-slit behind the fourth branchial arch. Rays in the anal fin less than 20.

Obs. Richardson gave this genus its name in 1844[e]. Though it had previously been formed by Heckel[f] under the name *Trachydermus*, this name was unavoidably rejected, as it had already been used both among insects and reptiles. In later times both the Scandinavian species which belong to it, have received from Krøyer[g] the generic name *Icelus*.

The genus *Centridermichthys*, with teeth both on the palatine bones and on the vomer, so far as dentition is concerned, forms the most decided contrast to *Gymnocanthus* of all the Cottoids; but in other respects is closely related to that genus. The relations between

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[a] In 1861 it was taken in Hornsund at a depth of 60 fathoms. According to Collett it has been taken by the Norwegian Arctic Expedition in Magdalene Bay (N. W. Spitzbergen) at a depth of 50 fathoms.

[b] Collett: Vid. Selsk. Forh. 1874, l. c.

[c] ♂, according to Lütken.

[d] ♀, according to Collett.

[e] *Voy. Sulph.*, *Fishes*, p. 73.

[f] Ann. Wien. Mus. 1880, II, p. 159.

[g] Naturh. Tidskr. Kbhvn, 2:den Rækkes 1:ste B. (1841—45), p. 251.

Centridermichthys and *Gymnocanthus* are in several respects similar to those which generally exist between the true *Cotti* and the fresh-water members of the family. In the former genus, for example, the mouth is larger and the anal fin shorter: the length of the maxillary bones is never less than 11 % of that of the body, and the length of the anal fin seldom exceeds 25 % of the length of the body, i. e. the length of the maxillary bones is never less than 44 % of that of the base of the anal fin. However, just as we can scarcely draw a generic distinction between the true and the fresh-water *Cotti*, we find, too, in the genus *Centridermichthys*, even in the two species of which we have now to treat, a distinct approach towards *Gymnocanthus*.

In the basin of the Atlantic *Centridermichthys*, as well as the preceding genus, contains only forms which belong to the extreme north, but in the Pacific at least one species is found as far south as the Philippine Islands. The number of species is not great: only 8 are known, most of them from the west coast of North America.

CENTRIDERMICHTHYS UNCINATUS.

Fig. 49.

Skin naked, without scales or the corresponding spinous formations, but sometimes with soft warts on the top of the head, as well as on the back above the lateral line. The two middle spines of the preoperculum almost wanting or only slightly developed: the upper spine bent, pointing backwards in an upward direction, and often with a lateral spine at the base; the lower pointing forwards in a downward direction. Only two slightly-developed spines on the top of the head, corresponding to the posterior (occipital) spines in the other Cottoids. On the hind part of the maxillary bones a small, conical, dermal flap. A similar flap sometimes on the hind part of the skin which covers the upper part of the eyes. Head fairly low and flat, its length from 28 to 30 % of that of the body. Length of the maxillary bones less than 12 % of that of the body, or from 57 to 60 % of that of the base of the anal fin. Length of the lower jaw less than 15 % of that of the body. Length of the base of the second dorsal fin less than 27 % of that of the body. Length of the base of the anal fin at least 80 % of that of the base of the second dorsal. Least breadth of the interorbital space less than half (from 30 to 40 % of) the least depth of the tail. Urogenital papilla of the male small[a]*. Eggs few and large*[b]*. Coloration light oil-brown on the back, yellowish white on the belly: 3 dark-brown transverse bands on the dorsal side — in young specimens a similar band on the head above the orbital region — but these transverse bands are generally broken up into an irregular mass of spots. Dorsal, pectoral and caudal fins with similar transverse bands; anal and ventral fins of the same colour as the belly, but sometimes with transverse bands or spots.*

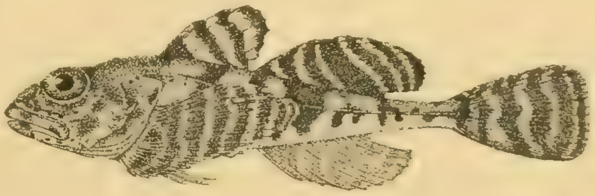

Fig. 49. *Centridermichthys uncinatus*, taken at a depth of from 5 to 10 fathoms, on a rocky, algous bottom, in Actinia Bay on the north coast of Taimyr Sound, in Aug., 1878. Temperature of the water at the bottom 29·9° Fahr.: at the surface 33·6° Fahr. Natural size.

Obs. The proportions given here, founded upon measurements of two males and two females, are intended to show, in comparison with the preceding genus and the following species, firstly, that the specific difference in *Centridermichthys* follows the same rules as in *Gymnocanthus* as described above, and secondly, that the characters of *Centr. uncinatus*, compared with those of *C. hamatus*, generally indicate a successive approach to *Gymnocanthus*.

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[a] It is, however, uncertain whether males ready to spawn have been examined.

[b] In two females respectively 87 and 92 mm. in length, from the Arctic Ocean off Ljakoff's Island (Siberia), taken in September, 1878, the eggs were about $2^{1}/_{3}$ mm. in diameter. COLLETT (l. c.) estimated the number of the eggs in females taken by the Norwegian Arctic Expedition at about 60.

R. br. 6; *D.* 7—9 | 12—14; *A.* 10—12; *P.* 18—21; $V. \frac{1}{3-4}$; *C.* x+8 | 9+x; *L. lat.* per. 24—28.

Syn. *Cottus uncinatus*, Reinh., Dansk. Vid. Selsk. Naturv. Math. Afh., Deel 6 (1837), Overs. p. LIII; ibid. Deel 7 (1838), pp. 114 et 118; Kr., (*Icelus*) Naturh. Tidskr. Kbhvn, 2:den Række, Bd. 1, p. 263; Esm., (*Centridermichthys*) Forh. Skand. Naturf. M. Christiania 1868, p. 517; Coll., Forh. Vid. Selsk. Christiania 1874, Tillægsh., p. 31; ibid. 1879, No. 1, p. 14; Id., *Norsk. Nordh.-Exp., Zool., Fiske*, p. 29, tab. I, fig. 7; N. Mag. Naturv., Bd. 29, Heft. 1, p. 54; Ltkn, Vid. Meddel. Naturh. For. Kbhvn 1876, p. 379; Lillj., *Sv., Norg. Fiskar*, vol. I, p. 161; Jord., Gilb., (*Icelus*) Bull. U. S. Nat. Mus., No. 16, p. 693.

Centridermichthys uncinatus is one of the small, though not of the smallest, Cottoids. On the coast of Greenland, according to Lütken, it attains a length of 100 mm. The size is said by Jordan and Gilbert to be the same on the east coast of North America, where it occurs as far south as Cape Cod. The largest of the specimens taken by the Vega Expedition are only slightly smaller, being about 92 mm. in length. These specimens were found in different parts of the Arctic Ocean off Siberia, from Taimyr Sound to the winter-quarters of the expedition near Behring Strait: they were taken at spots where the bottom was sandy or stony, and most often among seaweeds, at a depth of from 5 to 13 fathoms. The species was first described from specimens found in Greenland. On the coast of Norway it was first found by G. O. Sars in 1865, near Lofoden, and by Esmark in 1866, off Hammerfest. It was taken off Nova Zembla by Heuglin in 1871. It has subsequently been caught at various spots along the whole coast of Norway, as far south as the Whale Islands, on the Swedish frontier; but in its southern haunts, like other arctic forms, it lives at greater depths. Even in its true habitat, the Arctic Ocean, it was taken by the Norwegian Arctic Expedition at a depth of 223 fathoms, south-east of Bear Island. Singularly enough it has not yet been met with on the coasts of Spitzbergen or of Iceland.

Its food, like that of the preceding species, is composed of worms and crustaceans.

CENTRIDERMICHTHYS HAMATUS.

Fig. 50.

Skin for the most part naked, on the top of the head and the back more or less verrucose; but the openings of the lateral line supported by spinous, scaly formations, and between the dorsal edge and the lateral line one longitudinal row (in the males two or three) of spinous disks of bone or simple spines directed backwards — similar formations sometimes occur along the base of the anal fin — and also in the males scattered, spinous scales on the abdominal sides below the pectoral fins. Four preopercular spines, all well-developed, the uppermost bent, and usually (in adult specimens) branched (bicuspid). In the females only two occipital spines, each continued anteriorly into a ridge; but in the males there commonly appears, on the front part of these ridges as well, a protuberance or spine. On each side of the head[a] *3 fine, deciduous, dermal filaments, the largest of which has digitate divisions in the margin and is situated above the posterior part of the eye. The posterior part of the head and the body just behind the occiput somewhat elevated, and the profile of the head sloping steeply towards the snout. Length of the head from 28 to nearly 33 % of that of the body. Length of the upper jaw more than 12 % of that of the body or than 60 % of the base of the anal fin. Length of the lower jaw more than 16 % of that of the body. Length of the base of the second dorsal fin more than 28 % of that of the body. Length of the base of the anal fin less than 72 % of that of the base of the second dorsal. Least breadth of the interorbital space (at least in adult specimens) more than half the least depth of the tail. Anterior part of the lateral line straight or curved upwards. Urogenital papilla of the male long. Eggs somewhat smaller than those of the preceding species*[b]. *Coloration brownish yellow on the back, with dark-brown transverse bands, which are, however, usually broken up into irregular spots, on the head and the body — on the sides of the tail, below the lateral line, these spots are sometimes arranged in a longitudinal row — the ventral side a paler yellow; the pectoral fins thickly striped transversely with varying shades of dark-brown and yellow, as are also, though with fewer stripes, both the dorsal fins and the caudal fin, and sometimes the anal. The rest of the last fin is of the same colour as the belly, like the ventral fins, which are, however, sometimes spotted.*

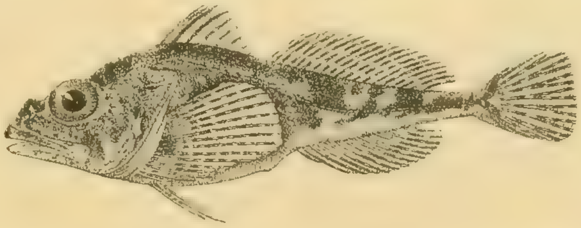

Fig. 50. *Centridermichthys hamatus*, ♀, from Fairhaven (Spitzbergen), taken at a depth of from 20 to 25 fathoms, on a clayey bottom, on the 30th of August, 1872. Natural size.

R. br. 6; *D.* 8[c]|19—21[d]; *A.* 14[e]; *P.* 17[f]; *V.* $^{1}/_{3}$; *C.* $x+(8)9+x$; *L. lat.* por. 35—45[g].

Syn. (?) *Cottus bicornis*, REINH., Dansk. Vid. Selsk. Math. Naturv. Afh., 8:de Deel, Overs., p. LXXV.

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[a] According to ESMARK and COLLETT.

[b] In a gravid female 55 mm. in length, taken in Liebde Bay on the 3rd of September, 1868, and also in another 75 mm. in length, taken on the 30th of August, 1872, in Fairhaven (Spitzbergen), the eggs are about $1^3/_4$ mm. in diameter.

[c] Sometimes 7, according to COLLETT; sometimes 9, according to KRØYER, COLLETT and LÜTKEN.

[d] Sometimes 17 or 18, according to MALMGREN and COLLETT.

[e] Sometimes 13, according to COLLETT; sometimes 15 or 16, according to LÜTKEN, COLLETT and KRØYER.

[f] From 17 to 19, according to COLLETT.

[g] The last number is given according to MALM. The first number given is taken from a female 63 mm. in length, from Spitzbergen — in this specimen the lateral line ends about half-way between the end of the base of the anal fin and the base of the caudal fin.

Icelus hamatus, Kroyer, Naturh. Tidskr. Kbhvn, ser. 2, vol. 1, pp. 253 et 262; Id., *Voy. Scand.* etc. (Gaim.) tab. I, fig. 2. Malmgr., Öfvers. Vet.-Akad. Förh. 1864, p. 507; Esm., Forh. Skand. Naturf. M. Christ. 1868, p. 518; Coll., Vid. Selsk. Forh. Christ. 1874, Tillægsh., p. 35; Ltkn, Vid. Meddel. Naturh. For. Kbhvn 1876, p. 380; Gthr. Proc. Zool. Soc. Lond., 1877, p. 293; Coll., Vid. Selsk. Forh. Christ. 1879, No. 1, p. 14; Id., *Norsk. Nordh. Exp., Zool., Fiske*, p. 34, tab. I, fig. 8; Lillj., *Sv., Norg. Fisk.*, vol. I, p. 164; Bean, Bull. U. S. Nat. Mus., No. 15, p. 128; Jord., Gilb., ibid., No. 16, p. 691; Coll., N. Mag. Naturv. Christ., vol. 29 (1884), p. 56.

Icelus furciger, Malm, Förh. Skand. Naturf. M. Stockh. 1865, p. 410; *Gbgs, Boh. Fn.*, p. 393.

Obs. Though Reinhardt states that the number of branchiostegal rays in *Cottus bicornis* is 7, still from the rest of his brief remarks on the species it seems highly probable, as Malmgren has already asserted, that this species is identical with Krøyer's *Icelus hamatus*, especially as a variation from 6 to 7 in the number of the branchiostegal rays, though not observed in any other case in this species, is fairly common in the following genus.

Centridermichthys hamatus is a fairly common species in Spitzbergen, where it has been found in most of the places examined by the Swedish expeditions, among the algæ and on a stony, sandy or clayey bottom, at a depth of from 6 to 80 fathoms. During the Norwegian Arctic Expedition it was taken off Jan-Mayen Island at a depth of 95 fathoms. On the coast of Greenland the species seems to be equally common; and the largest specimen known, a female 115 mm. in length, is mentioned by Lütken as taken there. During the "Sophia" Expedition of 1883 it was taken on a clayey bottom, at a depth of from 10 to 20 fathoms, north of Cape York; and according to Günther it is one of the most common fishes in these regions between latitudes 80° and 82° N. According to Jordan and Gilbert it occurs on the coast of Alaska; and the Vega Expedition obtained specimens from the coast of Siberia west of Taimyr Peninsula. It is thus a circumpolar species, but roves south in the Atlantic as far as the Skager Rack, where a specimen 52 mm. in length was taken by A. W. Malm in 1861, at a depth of less than 20 fathoms, off Löken at the entrance of Gullmar Fjord. Its food is probably the same as that of the preceding species: we have found in its stomach numbers of the bristles of Annelidans.

Genus TRIGLOPS.

Two distinct dorsal fins. Lateral line covered with scales, which are dentated at the upper margin of the opening ducts; a row of spinous plates along each side of the dorsal fins; the rest of the skin naked, verrucose (on the head and above the lateral line) or gathered into oblique, transverse folds, fringed or dentated at the margin (on the sides below the lateral line). Head middle-sized and, like the anterior part of the body, posteriorly elevated and compressed. Four simple spines in the margin of the preoperculum. Jaws and the head of the vomer with teeth, but the palatine bones toothless. Branchiostegal membranes inferiorly united, but free from the isthmus. Gill-slit behind the fourth branchial arch shrunk into a hole. Urogenital papilla of the male long. Rays in the anal fin more than 20.

The genus *Triglops* was first introduced into the system in 1832 by Reinhardt[a], as a subgenus of *Cottus*, on account of the smaller size of the head; the narrower pectoral fins with their lower rays free to a greater extent; the greater breadth of the preorbital bone; and the large number of rays in the posterior dorsal and the anal fins. As a genus, however, its characters were more fully given first by Krøyer, in 1845. It contains only one known species, named after the explorer of Greenland, Dr. Pingel, who in 1829 obtained the first specimen known.

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[a] Dansk. Vid. Selsk. Naturv. Math. Afh., 5:te Deel Overs. p. LII.

TRIGLOPS PINGELII.

Fig. 51.

Body posteriorly elongated. Length of the head about 27 % of that of the body[a]. *Preopercular spines comparatively small. Spines on the top of the head small, eventually disappearing with age. Snout in old specimens longer, in young specimens shorter, than the longitudinal diameter of the eye, which varies with increasing age from 30 to 26 % of the length of the head. Least breadth of the interorbital space*[b] *in old specimens greater, in young specimens slightly less, than the least depth of the tail*[c]. *Length of the maxillary bones less than 12 % of the length of the body or than 37 % of that of the base of the anal fin, which is more than 28 % of the length of the body or than 90 % of the base of the second dorsal fin, the last measuring from 30 to 33 % of the length of the body. Length of the lower jaw less than 16 % of that of the body. Base of the pectoral fins vertical and fairly straight, the length of these fins measured from the upper corner of their insertion being about 21 % of the length of the body, or slightly less than when measured from the lower corner, in which case it is 22 %; the lower and thicker rays free for a relatively great part of their length. Head superiorly and laterally, and the back above the lateral line, in adult specimens, covered with a verrucose skin, which is firmly united to the subjacent bones, and shagreened on the head. The breast (the ventral side in front of the ventral fins) with the skin gathered into transverse folds, like those belonging to the sides of the body below the lateral line, but the ventral side from the ventral fins to the vent smooth. Anterior part of the lateral line curved downwards. Coloration essentially the same as that of the preceding species, but the dark spots on the sides are blacker in full-grown specimens, and the belly is purer white and even lustrous.*

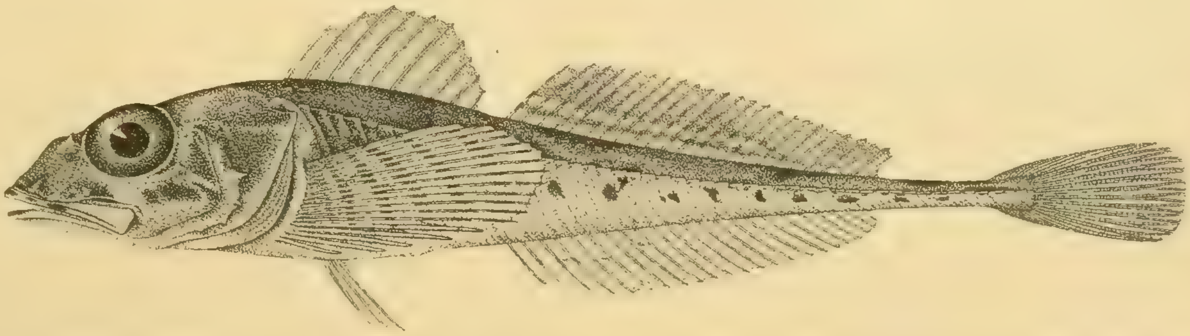

Fig. 51. *Triglops Pingelii*, ♀, natural size. From a depth of 30 fathoms in Behring Strait; July, 1879; Vega Expedition.

R. br. 6[d]; *D.* 10—11[e] 23—25[f]; *A.* 22—25[f]; *P.* 18[g]; *V.* $^{1}{}_{3}$; *C.* $x+9+x$; *Lin. lat.* 49[h].

Syn. *Triglops Pingelii*, Reinh., Dansk. Vid. Selsk. Math. Naturv. Afh., Deel 7, pp. 114 et 118; Krøy., Naturh. Tidskr. Kbhvn, ser. 2, vol. 1, p. 261; Id., *Voy. Scand., Lap.* (Gaimard), tab. I, fig. 1; Malmgr., Öfvers. Vet.-Akad. Förh. 1864, p. 508; Esm., Forh. Naturf. Möde Christ. 1868, p. 520; Coll., Forh. Vid. Selsk. Christ. 1874, Tillægsh., p. 36; Ltkn, Vid., Meddel. Naturh. For. Kbhvn 1876, p. 378; Gthr, Proc. Zool. Soc. Lond. 1877, p. 476; Coll., *Norsk. Nordh. Exp., Zool., Fiske*, p. 38, tab. 1, fig. 9 et 10; Lillj., *Sv., Norg. Fisk.* vol. I, p. 168; Bean., Bull. U. S. Nat. Mus., No. 15, p. 128; Jord., Gilb., ibid. No. 16, p. 713.

Triglops pleurostictus, Cope, Proc. Acad. Nat. Sc. Phil. 1865, p. 81.

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[a] In a specimen $37\frac{1}{2}$ mm. in length the length of the head = 27·2 % of that of the body; in two specimens 154 mm. in length 27·3 %.

[b] In old specimens about 36 % of the longitudinal diameter of the eye, in young 39 %.

[c] In old specimens the latter is as much as 2·1 % of the length of the body, in young as much as 3·4 % or even 4·2 %. During youth this species thus corresponds, in this respect, to the older stages of the three preceding species.

[d] Sometimes 7, according to Krøyer and Lütken.

[e] Sometimes 12 or 13, according to Krøyer, Lütken and Collett.

[f] Sometimes 26, according to Collett. In a specimen from the Cattegat there are only 20 rays in the second dorsal fin.

[g] 17—19, according to Lütken; 17—21, according to Collett.

[h] 45—49, according to Collett.

Triglops Pingelii is known in Greenland[a], Jan-Mayen Island[a] and Spitzbergen as a fairly rare species. It was not until 1877 that the British Museum was successful in obtaining a specimen. The Swedish expeditions to Spitzbergen, however, have taken it at several spots in the northernmost parts of these islands and in Stor Fjord, at depths varying from 3 or 4 up to 105 fathoms. The Vega Expedition brought home a small specimen, taken at a depth of 15 fathoms, north of their winter-quarters in Behring Strait, and two females 154 mm. in length, taken at a depth of 30 fathoms, off Port Clarence. The geographical extension of the species is thus circumpolar. On the coast of America, according to JORDAN and GILBERT, its range extends from Greenland as far south as Cape Cod. In Norwegian Finmark it was found in 1866 by ESMARK at a depth of 30 fathoms, off Hammerfest, and by LOBERG near Vadsö. It has been met with by G. O. SARS near the Lofoden Islands at as great a depth as 150 fathoms, and also off Christiansund. COLLETT also mentions a specimen, a gravid female 163 mm. in length, from North Cape, and several others, the largest of which was 80 mm. in length, from the neighbourhood of Tromsö. It must be regarded, however, as one of the rarest Scandinavian fishes. Its occurence in the Cattegat is, therefore, highly remarkable. A specimen 13 cm. in length (excluding the caudal fin) was taken here by Mr. A. SVENSSON, taxidermist to the Royal Museum, during a visit to Träslöf, near Varberg, in the summer of 1867. It was subsequently stuffed by the same gentleman, and presented to Christianstad Museum. By the kindness of Lecturer WAHLSTEDT we have been enabled to examine this specimen. In it we find *D.* 10|20; *A.* 22; *P.* 17; there thus being an uncommonly small number of rays in the second dorsal fin. The black spots below the lateral line, too, are united into a broad, undulating, longitudinal stripe, extending as far as the caudal fin, and more continuous and distinct than those we have seen in arctic specimens. These differences, however, can scarcely be regarded otherwise than as individual peculiarities.

The food and the manner of life of this species are probably the same as those of the preceding one, even if, as COLLETT states, it be still more truly a bottom-fish. This opinion is borne out by the formation of the lower rays in the pectoral fins, which are free to a still greater extent of their length, and by the help of which it probably creeps or flounders along in exactly the same way as the Gurnards. COLLETT estimates the number of eggs in a female 102 mm. in length at five or six hundred.

GENUS **COTTUS.**

Two distinct dorsal fins. Skin naked or with spines or spinous tubercles. Head fairly large, but never more than $^1/_3$ *of the length of the body. Uppermost preopercular spine simple, straight or curved. Palatine bones toothless, but the vomer with teeth. Branchiostegal membranes either united by a free fold across the isthmus or separated by the latter. Gill-slit behind the fourth branchial arch wanting or shrunk into a hole. Less than 20 rays in the anal fin.*

With the limitations generally given to this genus at the present time, it contains some forty more or less known or recognised species[c]. As ARTEDI in his arrangement of the genus gave the first place to the River Bullhead (*Cottus gobio*), this species has been adopted as the true type of the genus[d], and when GIRARD, in 1849[e], formed a special genus to receive the fresh-water *Cotti*, which in America seem to be far more numerous than in the Old World, basing his arguments on the weaker spinous equipment of the head, the less marked division between the head and the body, the smaller mouth and the lower dorsal fin of these species, he retained the name *Cottus* for this genus and gave the other *Cotti* the generic name *Acanthocottus*.

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[a] REINHARD, MALMGREN, LÜTKEN and GÜNTHER, ll. cc.

[b] COLLETT, l. c.; at a depth of from 70 to 263 fathoms.

[c] JORDAN and GILBERT recognise 34 North American species of this genus.

[d] CUV., VAL., *Hist. Nat. Poiss.*, vol. IV, p. 143.

[e] Proc. Bost. Soc. Nat. Hist., vol. III, p. 183.

Dekay[a], however, had previously adopted one of the American fresh-water *Cotti* as the type of a new genus, *Uranidea*, a name which has thus an older claim to employment, even though this claim was dubious, so long as only one species of the genus was known. In a group so naturally connected as that of the *Cotti*, it is always convenience, the convenience needed to facilitate the inspection of a genus, that in the first place decides the necessity of its systematic division; and in a local fauna, where the number of species is no greater than, for example, in Scandinavia, this question loses a great part of its importance. Lütken has pointed out[b] the impossibility of maintaining the distinctions between these genera by the help of fixed characters. Fixed characters are however to be found. The fact that a fish lives in fresh water is in itself by no means a sufficient ground for its systematic isolation — the River Bullhead occurs in the Baltic, and the Four-horned Cottus lives in the larger Swedish lakes — but this manner of life, probably, has set on the fresh-water *Cotti* an impress of the juvenile stages in the development of the others, which also attain a greater size than they. One apparent proof of this is the fact that in Lake Wetter young specimens of the Four-horned Cottus have a smaller head than those of the same age in the Baltic or the Arctic Ocean. Again, the River Bullhead and its relative the Alpine Bullhead (*Cottus poecilopus*) have the smallest head of all the Scandinavian *Cotti*, and might be distinguished from the others by means of this character, had not the circumstance mentioned above caused an encroachment of the character of the Four-horned Cottus in this respect upon the limits of the variations of the Alpine Bullhead. The above-mentioned characters given by Girard to the fresh-water *Cotti* also hinge upon the fact that they correspond to the juvenile stages of the other *Cotti*. But the smaller size of the gape, combined with another peculiarity, the length of the base of the second dorsal fin, which according to our observations is generally longer, form a constant character, on which we base our present adoption of the fresh-water *Cotti* as a distinct subgenus. The species which occur in the Scandinavian Fauna may be distinguished by the help of the following table:

A: Length of the maxillary bones less than 36 % and the length of the lower jaw less than 44 % of the length of the base of the second dorsal fin. Head without spines on the top or on the snout: — Subgenus *Uranidea*.

a: Length of the base of the anal fin less than 48 % of the distance between this fin and the tip of the snout . . . . *Cottus gobio.*

b: Length of the base of the anal fin more than 53 % of the distance between this fin and the tip of the snout . . . . *Cottus poecilopus.*

B: Length of the maxillary bones more than 38 % and the length of the lower jaw more than 50 % of the length of the base of the second dorsal fin. Head with spines on the top as well as on the snout: — Subgenus *Acanthocottus*.

1: Least depth of the tail less than $4^1/_2$ % of the length of the body and less than 21 % of the base of the anal fin *Cottus quadricornis.*

2: Least depth of the tail more than $4^1/_2$ % of the length of the body and more than 24 % of the base of the second dorsal fin.

a: Lateral line smooth, with a downward curve at the end of the second dorsal fin. Margins of the branchiostegal membranes united to each other by a free dermal flap under the isthmus. No dermal papillæ on the upper jaw-bone . . . . *Cottus scorpius.*

b: Lateral line spinous, without any visible curve in the posterior part. Branchiostegal membranes united to and separated by the isthmus. At least one dermal papilla on the posterior part of the upper jaw-bone:

α: Four rays in the ventral fins *Cottus bubalis.*

β: Three .. .. *Cottus Lilljeborgii.*

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[a] *N. York Fn.*, vol. IV, *Fish*, p. 61.

[b] Vid. Meddel. Naturh. For. Kbhvn, 1876, p. 366.

THE RIVER BULLHEAD (SW. STENSIMPAN).

COTTUS GOBIO.

Plate VIII, fig. 1.

Among the bones of the head only the suboperculum and preoperculum furnished with spines, and only the uppermost preopercular spine distinctly prominent, forming a hook pointing upwards in a posterior direction, and curved inwards, the second spine scarcely projecting above the skin, and the third apparent only as a tubercle. The spine at the lower corner of the suboperculum is directed forwards, but scarcely projects above the skin[a]. *The distance, which increases with age, between the anal fin and the tip of the snout, in adult specimens at least, is never less than 48 % of the length of the body, and the length of the base of the fin is under 48 % of this distance. The innermost ray of the ventral fins measures more than half their length. Branchiostegal membranes united to and separated by the isthmus. The length of the maxillary bones is greater in the male than in the female and varies between about 24 and 35 % of the length of the base of the second dorsal fin: the length of the lower jaw, which is subject to the same difference according to sex, varies between 33 and 44 % of the length of the base of the same fin.*

R. br. 6; *D.* 7[b]—9 16—18; *A.* 11—13; *P.* 13 l. 14; *V.* $^1/_4$; *C.* *x*+8 l. 9+*x*; *L. lat.* por. 33—36.

Syn. *Cottus* alepidotus glaber, capite diacantho, ART., *Gen.*, p. 48, *Syn.*, p. 76; *Spec.*, p. 82.

Cottus capitatus, LIN *Mus. Ad. Frid.*, vol. I, p. 70.

Cottus Gobio, LIN., *Syst. Nat.*, ed. X, tom. I, p. 265; *Fn. Succ.*, ed. 2, p. 115; RETZ., *Fn. Suec. Lin.*, p. 329; CUV., VAL., *Hist. Nat. Poiss.*, vol. IV, p. 145; EKSTR., Vet.-Akad. Handl. 1831, p. 308; NILSS., *Prodr. Ichth. Scand.*, p. 98; EKSTR. et WRIGHT, *Skand. Fisk.*, ed. 1, p. 34, tab. 7, fig. 2; KRØY., *Danm. Fiske*, vol. 1, p. 141; SUNDEV., Öfvers. Vet.-Akad. Förh. 1851, p. 185; ID., Stockh. L. Hush. Sällsk. Handl., 1855, p. 179; NILSS., *Skand. Fn.*, *Fisk.*, p. 64; GTHR, *Cat. Brit. Mus.*, *Fish.*, vol. II, p. 156; SIEB., *Süsswasserf. Mitteleur.*, p. 62; MGRN, *Finl. Fisk.*, p. 4; LTKN, Vid. Meddel. Naturh. For. 1865, p. 218; LINDSTR., *Gotl. Fisk.* (Gotl. L. Hush. Sällsk. Årsber. 1866) p. 14 (sep.); BLANCHARD, *Poiss. d. eaux douces de la France*, p. 161; MALM, *Gbgs, Boh. Fn.*, p. 387; FEDDERSEN, Naturh. Tidskr. Kbhvn, ser. 3, vol. XII, p. 73; DAY, *Fish. G:t Brit.*, *Irel.*, vol. I, p. 46; LILLJ., *Sv.*, *Norg. Fisk.*, vol. I, p. 125; MOR., *Hist. Nat. Poiss. Fr.*, vol. II, p. 293; MÖB., HCKE, *Fisch. Osts.*, p. 48.

Cottus affinis, HECKEL, Ann. Wien. Mus. Naturg., vol. 2 (1836), p. 146.

Obs. In his *Systema Naturæ* (l. c.) LINNÆUS has overlooked the circumstance that four years before he had called this species *Cottus capitatus*, deriving the specific name from GESNER (*Gobio fluviatilis capitatus*) *De Aquat.*, p. 477.

This species and the following one are the smallest of the true *Cotti* in Scandinavia. The usual size of the River Bullhead, when full-grown, is between 75 and 100 mm., though specimens have been met with up to a length of 125 mm.[c]. Small as is its importance in an economical respect, its interest from a scientific point of view is nevertheless great, partly for its breeding habits, and partly for the differences between it and its relatives, wherein it represents the transition from the genus *Cottus* to *Callionymus*, *Gobius* etc.

The body is of the usual round Cottoid-form, tapering like a cone posteriorly: the sides of the tail are somewhat compressed. The head, the length of which varies between 25 and 27 % of that of the body, is depressed and broader than the trunk, but, like that of the following species, differs from the others in the following respects: it is entirely without projecting spines or knobs and has no trace of the elevations which appear in the other *Cotti* on the top of the head. It is thus rounded evenly at the top towards the sides and the snout, which is also rounded anteriorly, and flatter underneath. The eyes are set on the slope, somewhat nearer the snout than the occiput, and at a distance from each other which in adult specimens may indeed be externally equal to the vertical diameter of the eye, but if we measure only the least interorbital breadth of the frontal bone, is at most $^1/_2$ the horizontal diameter of the eye. They project considerably and are turned somewhat upwards[d], a circumstance which causes the profile of the head to appear compressed behind the eyes. The gape is broad and almost horizontal and the jaws project equally, but the upper jaw-bone is short and extends back only to a point vertically below the anterior margin of the eye. The length of the upper jaw-bone in the female is between $7^1/_2$ and $8^1/_2$ % of that of the body and in the male about $10^1/_2$ %, or in the former between 33 and 41 and in the latter about 46 % of the length of the base of the anal fin. The length of the lower jaw varies between 11 and 13 % of that of the body. The lips are thick and swollen, like the cheeks. The whole appearance of the head thus gains a close resemblance to that of the genus *Gobius*. The nostrils are small and open on each side into two fine ducts, as is usually the case in this genus; the anterior opening is the larger and is situated about half-way between the snout and the eye. In this, as in the other species of the genus, small cardiform teeth are set on the lower jaw, the intermaxillary bones and, in a curve anteriorly convex, on the head of the vomer. Underneath, from the lower margin of the pectoral fins, the branchiostegal membranes are united to the breast, without any free dermal fold across it; partly on this account and partly in the opercular flap, which is more deeply incised at the top, there is a slight resemblance, of which more hereafter, to the structure of the gill-openings in *Callionymus*. The hind margin of the preoperculum is furnished at the top with a small, flat hook, turned upwards, but the interstice between the margin of the preoperculum and the point of the hook is filled by the skin. Below this hook — in which we may trace a fairly distinct likeness to the many-pointed preopercular hook in *Callionymus*, as well as to the corresponding structure we have seen in *Centridermichthys* — is another, slightly projecting, flat spine with broad base and blunt tip, which is generally very indistinct, though it varies in size. The lateral line, which is marked by about 33 small, short, porous openings, is without any armour and runs fairly straight forward from the caudal fin, at about the middle of the side, but below the first third of the second dorsal fin curves slightly downwards and then, in a line with the vent, gradually rises to such an extent, that at the margin of the gill-cover it is much nearer the back. The skin is smooth, scaleless and covered with a thick and tough mucus over the whole body. Even in this species, but still more commonly in the following one, we sometimes find the anterior part of the sides — the part which is covered by the pectoral fins — sprinkled with small, spinous, scaly formations, which are more easily felt than seen. The two dorsal fins are united at the base, and the second is fairly long in proportion to the size of the fish — so long that there is only a short interval between the end of this fin and the beginning of the caudal fin. In the ventral fins we find a remarkable exception to the rule within the genus, namely that they have one ray more, i. e. they contain one spinous and four weak, articulated rays; the spinous ray is, as usual, closely joined to the first weak ray and hidden by the skin. The length of these fins is, as usual, greater in the male than in the female, but, so far as our observations extend, does not exceed $17^1/_2$ % of the length of the body or 35 % of the distance between the anal fin and the tip of the snout. In the anal fin it is worthy of remark that the last two rays are close together at the base and that the base of this fin measures at most about 23 % of the length of the body. In the caudal fin, which is sharply rounded at the end, the 7 or 8 middle rays are quadrifid or doubly bifid; in most cases too, in old specimens at least, there is one more bifid ray. Furthermore, in this species as in the following one, more at least than in the others, the rays of most of the fins, especially of the pectoral and ventral, have a tendency to divide at the point. This is visible only under a magnifying glass; to the naked eye, however, the rays seem simple.

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[a] The spine which is situated at the lower posterior corner of the interoperculum and directed backwards, is present, but is extremely indistinct.

[b] Sometimes 6 according to VALENCIENNES and LILLJEBORG, or 5 according to MÖBIUS and HEINCKE.

[c] MÖBIUS and HEINCKE say even 150 mm.

[d] Hence the name of *Uranidea*, with a reference to the resemblance to *Uranoscopus* (GRONOV., Mus., 2, No. 166; DEKAY, l. c.).

The coloration, as usual, varies considerably, from early youth, when the dark transverse bands which are general in the Cottoids, are more regular and distinctly marked. In adult specimens the body is of a grayish green colour, with irregular spots and transverse stripes of varying size and shape. The dorsal side is marbled with gray and brown right out on the snout. The lateral line is coasted underneath by some lighter, yellowish spots, which are more distinct in some individuals than in others. The rays of the caudal, the second dorsal, the anal and the pectoral fins are crossed by light streaks, which together form bands, partly broken and partly continuous, over the fins. These light transverse streaks give a broken appearance, as it were, to the rays. In the males the belly is of the same colour as the body, though somewhat lighter; in the females it is whitish. The ventral fins are generally without spots and of the same colour as the belly, but they are sometimes dotted or even spotted with black. The iris is dark, with a flame-yellow ring round the inner margin. The figure (plate VIII, fig. 1) is painted from a male, taken in the Baltic, in the month of July.

In the internal organs of this species we find no considerable difference from those of the rest of the genus. The liver lies right across the anterior part of the abdominal cavity, with its greater portion on the left side. The intestine forms the same curves as in the other species, but there are only four, rather large, pyloric appendages. The ovaries are black, the milt of a brownish colour, and the peritoneum silvery, spotted with black.

The River Bullhead is of common occurrence in Sweden both along the coast of the Baltic and in fresh water. In Denmark it was not found before 1865[a], when it was taken by Lorenzen in Zealand. In Norway, according to Collett, its place is taken by the Alpine Bullhead. It also occurs throughout all Europe north of the Pyrenees and Greece, and according to Günther[b], in Northern Asia. Whether it coincides with any of the fresh-water *Cotti* of North America[c], still seems a matter of doubt, however probable it may appear. Throughout this wide geographical range it is most often found at spots where the water is clear and the bottom consists of sand and pebbles. It does not live in large shoals, but leads a solitary existence apart from its fellows; it frequents shallow beaches and at spots of this nature is seldom sought in vain, if one raises the stones. It is under them that it usually passes its time in quiet and inactivity, watching from its lurking-place for the insects, worms, Gammaroids and other small crustaceans, or the fry or even the small fishes of no inconsiderable size, which may approach and fall a prey to its voracity. According to Benecke it is especially fond of Trout-ova[d]. Its movements are quick; when driven from its shelter, it darts with the speed of an arrow under the nearest stone or other suitable place of refuge. This peculiarity in its way of life has given rise to the various names by which it is known in different parts of Sweden, as *Stensugare* (Stone-sucker), *Stensut* (Stone-tench), *Stenlake* (Stone-burbot) etc. The spawning-season extends from the latter part of winter[e] into the month of May[f]. In 1726 Marsigli stated, in his description of the Danube[g], that the female, the belly of which is almost monstrously distended during pregnancy, lays its eggs in March, first preparing a hiding-place for them by scraping a hole with its tail under a stone, or fastens them to stones or bridge-piles driven into the bottom. It then, however, deserts them, and the male takes its place as their protector and guards them for a month, until the young are able to shift for themselves. In more modern times Heckel and Kner[h] received trustworthy information to the same effect from some fishermen of the Drave, one of the tributaries of the Danube, who added that it was the male that searched for the hole to receive the eggs[i] and then defended it with desperate courage. Before the latter authors had given their opinion in favour of the truth of this assertion, Ekström[j] doubted its veracity on the ground that he "had often seen this fish close to its roe, when it was just as timid as usual and did not make the slightest attempt to defend it." More minute observations are still needed on this point[k]. Sundevall (l. c.) found the eggs "in a mass, firmly attached to small stones, close in shore" in the island-belt near Stockholm.

The flesh of the River Bullhead is white, but is said to turn red when boiled[l]. It is stated by many to be of extremely good flavour; but as the fish is never so large as to render it worth while to catch and prepare it, there is no special fishery for it. It is, however, an excellent bait, especially for Eels and Perch. It may be easily taken with a forked stick of suitable size, if one cautiously lifts the stone under which it has hidden itself.

(Ekström, Smitt.)

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[a] See Lütken, l. c.

[b] *Study of Fishes*, p. 477; *Handb. Ichthyol.*, p. 338.

[c] Cf. Day, l. c., p. 49.

[d] *Handb. Fischz. Fischerei*, by Benecke, Dalmer and Max v. d. Borne, p. 79.

[e] February, according to Möbius and Heincke, l. c.; cf. also Malmgren, l. c.

[f] G. C. Cederström, *Fiskodling och Sveriges Fiskerier*, p. 231.

[g] *Danubius Pannonico-Mysicus*, tom. IV, p. 73.

[h] *Susswasserfische der Oesterreichischen Monarchie*, p. 30.

[i] Cf. the account of *Batrachus* given above.

[j] Vet.-Akad. Handl., 1831, p. 311.

[k] Cf. Blanchard, l. c., p. 170.

[l] Cuv., Val., l. c., p. 152. Day, l. c., p. 48, states that this is a peculiarity confined to certain localities.

THE ALPINE BULLHEAD (SW. BERGSIMPAN[a]).

COTTUS POECILOPUS.

Fig. 50.

Head armed as in the preceding species, but the uppermost preopercular spine not so curved, sometimes almost straight. Distance between the anal fin and the tip of the snout at most 47 1/2 % of the length of the body, and the length of the base of this fin more than 50 %[b] of this distance. Length of the innermost ray of the ventral fins less than half, or even than a third of the length of the fins. Gill-openings as in the preceding species, and also the relative length of the jaws.

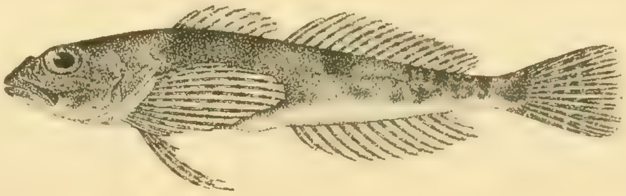

Fig. 50. *Cottus poecilopus* from Motala River, 1st Oct., 1861, C. Sundevall. Natural size.

R. br. 6[c]: *D.* 7 l. 8[d] 17[e] l. 18: *A.* 14[f]; *P.* 13 l. 14; *V.* $^1/_4$: *C.* $x + 7$—$9 + x$: *L. lat.* sæpiss. imperf.

Syn. *Cottus poecilopus*, Heck., Ann. Wien. Mus., II (1836), p. 145, tab. 8, fig. 1 et 2; Sund., Öfvers. Vet.-Akad. Förh. 1851, p. 185; Nilss., *Skand. Fn., Fisk.*. p. 67; Heck., Kn., *Süsswasserf. Oesterr.*, p. 31; Gthr, *Cat. Brit. Mus., Fish.*, vol. II, p. 157; Jeitt., Arch. p. l. Zoologia, vol. I, p. 175; Lindstr., *Gotl. Fisk.*, l. c., p. 14 (sep.); Coll., Forh. Vid. Selsk. Chrnia 1874, Tillægsh., p. 24; 1879, No. 1, p. 12; Olsson, Öfvers. Vet.-Akad. Förh. 1875, No. 3, p. 129; Malm, *Gbgs, Boh. Fn.*, 388; Lillj., *Sv., Norg. Fiskar*, vol. I, p. 131.

Cottus gobio, Day, *Fish. G:t Brit., Irel.*, vol. I, tab. XIX, fig. 2.

Obs. None of the Scandinavian species of this genus has been so variously estimated, and justly so, as the Alpine Bullhead in its relation to the preceding one. Most of the characters given by Heckel can scarcely be retained, and only one of them — that which consists in the length of the innermost ray of the ventral fins, a point not touched upon by Heckel in his latest work — may be regarded as an unmistakable mark of the species, as far as we know it up to the present. Furthermore, Malm, Day, Benecke and Möbius and Heincke still maintain the opinion that the two species are not distinct. On examining the different relations of age and sex in both species (see the appended table), we also find that their relative positions in the chain of development indicate a common origin of a period not far removed from the present. In all the respects in which *Cottus poecilopus* differs from *Cottus gobio*, it exhibits the juvenile or the male characters of the latter, or both combined. This appears most clearly from a comparison between the length of the ventral fins and the distance from the anal fin to the tip of the snout, for the relative size of the fins gradually diminishes with age — provided that this be expressed by the increase in the length of the body — and is greatest in the males and greater in *Cottus poecilopus* than in *Cottus gobio*. It is also strange that, while in *Cottus gobio* the females are more common than the males, the contrary is the case in *Cottus poecilopus*, at least in the collections of the Royal Museum. Again, in the south and east of Sweden at least, no fixed limits can be set to the range of either species: Sundevall found both in the island-belt of Stockholm, they occur together in Motala River, and Lindström assigns them both to Gothland, even though it be to different lakes. It is, therefore, easy to understand how confusion has often arisen in the specific and sexual differences of the two species. The following comparative table may afford more minute information on this point.

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[a] Lilljeborg, l. c.

[b] At least 53 % in the specimens we have measured.

[c] Sometimes 5, according to Heckel.

[d] Or 9, according to Heckel.

[e] Or 16, according to Heckel.

[f] Or 13, according to Heckel.

	Cottus gobio.					*Cottus poecilopus.*				
	Lake Forssa, Helsingland, Nov. 1882.	Islands near Stockholm, Aug. 1851.	Lake Forssa, Helsingland, Nov. 1882.	Lake Forssa, Helsingland, Nov. 1882.	Islands near Stockholm, Aug. 1854.	Qvickjock 1860.	Björknäs.	Björknäs.	Motala.	Motala.
	♀	♀	♀	♀	♂	♀	♀	♂	♂	♂
Length of the body in mm	72.0	75.0	86.5	89.0	78.0	67.5	68.0	45.0	77.5	93.0
.. .. .. head in of the length of the body	25.0	25.3	26.0	25.8	26.9	24.1	26.5	25.8	26.6	28.5
.. .. .. maxillary bones	7.6	8.5	8.5	8.1	10.6	7.7	8.1	7.7	9.0	9.7
.. .. .. lower jaw	11.5	11.1	12.7	11.2	13.1	10.8	12.1	11.6	12.9	13.3
.. .. .. ventral fins	17.0	16.1	16.2	15.7	17.4	17.4	19.1	18.2	19.3	20.4
Distance between the ventral fins and the anal fin in % of the length of the body	27.8	27.4	24.4	28.1	23.1	21.0	22.1	22.2	23.5	25.8
.. .. .. anal fin .. .. tip of the snout	48.6	48.2	50.4	51.1	50.0	44.4	47.1	44.9	47.1	47.3
Base of the	23.0	22.4	20.8	21.8	23.1	25.5	25.0	26.7	25.8	25.8
Least depth of the tail	5.8	5.6	5.8	5.6	5.8	5.6	5.3	4.7	5.3	6.0
Base of the anal fin in % of the distance between this fin and the tip of the snout	47.4	46.4	41.3	42.6	46.2	57.3	53.1	59.4	54.5	54.5
Length of the ventral fins .. .. .. their insertion and the anal fin	61.0	58.8	66.0	56.0	75.5	83.1	86.6	82.0	82.4	79.2
.. .. the anal fin and the tip of the snout	34.8	33.4	32.1	30.8	35.0	39.3	40.6	40.6	41.1	40.3

The Alpine Bullhead, which attains a length of about 14 cm., is in most respects so like the preceding species that a minute description is unnecessary. The length of the jaws, the ventral fins and the base of the anal fin, which is generally greater in this species, and the distance from the tip of the snout to the beginning of the anal fin, which is generally less, form its true characters. The species owes its systematic name (*poecilopus*, "with variegated foot") to the blackish transverse bands which usually appear on the ventral fins; and in most cases this character holds good, though these bands are often indistinct, while in *Cottus gobio*, too, the ventral fins are often spotted with black. In all the specimens we have examined, even in the females, there are numerous and very distinct, but scattered, spinous scales on the anterior part of the sides, even above the lateral line. We have always found the lateral line imperfect, or at least that its openings and pores become indistinct at the middle of the second dorsal fin and sometimes just behind the beginning of this fin; but its usual course to the base of the caudal fin is generally indicated by a groove in the skin. In this respect, however, *Cottus poecilopus* does not stand alone: the posterior part of the lateral line is indistinct and apparently destitute of pores in the generality of cases — though to a less extent — in *Centridermichthys hamatus*, *Cottus quadricornis* and occasionally in *Cottus gobio*, where, however, it is generally perfect or perhaps becomes indistinct for a small part of its course to be again continued by distinct pores further back.

The Swedish name which LILLJEBORG has given this species, *bergsimpa* or 'Mountain Bullhead', is really founded on the circumstance that it was first described as an inhabitant of the mountain torrents among the Carpathians — according to a statement of doubtful authenticity it also occurs in a similar way among the Pyrenees. Its geographical range is, however, far too little known as yet to admit of any decided inference being drawn from this circumstance, especially as it so closely resembles the common River Bullhead even in colour and in its habits that the species may well have been confused on many occasions where a most careful examination has not been made. LILLJEBORG, however, rightly points out that it has been found in one of the northernmost Swedish lakes, Saggat Mere near Qvickjock (WIDEGREN), in the lakes of Jemtland — where, according to OLSSON, it is called *Stengers* (Stone-ruff) *Lakegers* (Burbot-ruff) and *Lakatrubb* (Flat-nosed Burbot) — and in Lake Nämm in Småland (PORATH and THEORIN), and that COLLETT assigns only this species, and not the preceding one, to the rivers and lakes of Norway south of Dovre Field. It would thus appear in Scandinavia too, to belong more or less entirely to the mountain-regions, though, as SUNDEVALL has shown, it lives together with *Cottus gobio* in the island-belts of the Baltic. That it also occurs in England, appears from DAY's figure which we have mentioned above, and which is drawn from a specimen caught in the Chern, one of the upper tributaries of the Thames.

THE FOUR-HORNED COTTUS (SW. HORNSIMPAN).

COTTUS QUADRICORNIS.

Plate VI, fig. 2, ♀; Plate VII, fig. 1, ♂.

Top of the head furnished with spines and tubercles. Preopercular spines 4. Lateral line without spines. Length of the maxillary bones more than $^2/_5$, and of the lower jaw more than $^2/_3$ of the length of the base of the second dorsal fin. Least depth of the tail less than $4^1/_2$ % of the length of the body and less than 21 % of the base of the anal fin. Margins of the branchiostegal membranes united by a free dermal fold across the isthmus.

R. br. 5—7; *D.* 8 l. 9 13—15; *A.* 14 l. 15; *P.* 15—17; *V.* $^1/_3$; *C.* *x*+8 l. 9[a]+*x*.

Syn. *Cottus* scaber, tuberibus quatuor, corniformibus, in medio capite, ART., *Gen. Pisc.*, p. 48; *Syn.* p. 77; *Spec.*, p. 84.

Cottus quadricornis, LIN., *Mus. Ad. Frid.*, vol. I, p. 70, tab. XXXII, fig. 4; *Syst. Nat.*, ed. X, tom. I, p. 264; RETZ., *Fn. Suec. Lin.*, p. 328; PALL., *Zoogr. Ross. As.*, vol. III, p. 127; CUV., VAL., *Hist. Nat. Poiss.*, vol. IV, p. 168; EKSTR,, Vet.-Akad. Handl. 1831, p. 317; NILSS., *Prodr. Ichth. Scand.*, p. 98; EKSTR. et WRIGHT, *Skand. Fisk.*, ed. 1, p. 30, tab. VII, fig. 1; KRØY., *Danm. Fiske*, vol. I, p. 140; NILSS., *Skand. Fn., Fisk.*, p. 80; SUNDEV., Stockh. L. Hush.-Sällsk. Handl. 1855, pp. 80, 86, 178; GTHR, *Cat. Brit. Mus., Fish.*, vol. II, p. 166; LOVÉN, Öfvers. Vet.-Akad. Förh. 1862, p. 463; MGRN, *Finl. Fisk.* (disp.) p. 8; LINDSTR., *Gotl. Fisk.* (l. c.), p. 14 (sep.); LTKN, Vid. Meddel. Naturh. For. Kbhvn 1876, p. 375; MALM, *Gbgs, Boh. Fn.*, p. 390; DAY, *Fish. G:t Brit., Irel.*, vol. I, p. 49; LILLJ., *Sv., Norg. Fisk.*, vol. I, p. 144; MÖB., HCKE, *Fische d. Ostsee*, p. 47.

Cottus hexacornis, RICH., *Frankl. Journ.*, p. 726; *Fn. Bor. Amer.*, pt. III, p. 44.

This species and the following one are the largest of the Scandinavian *Cotti*, and in Sweden they attain about the same size, generally about 250 mm., but one may occasionally meet with specimens of the Four-horned Cottus which exceed this size. The appearance of the Four-horned Cottus is quite peculiar, owing to the strongly depressed head, especially when the gill-covers are extended; the small eyes, with the breadth of the interorbital space in large specimens greater than the longitudinal diameter of the eye, but in small ones considerably less; the less distinct projection of the upper orbital margin, in consequence of which the interorbital space is almost flat; the flatter and more elongated snout, which removes the spines of the two nasal bones farther from the eyes than in the following species, etc. The length of the head varies between 28 and 33 % of that of the body. The nostrils are small: the two openings on each side are, as is the rule in the genus, fairly widely separated by the nasal bone; the anterior is situated nearest the snout and the posterior just in front of the anterior margin of the eye; both open into cylindrical or funnel-shaped dermal tubes. The two lateral ridges on the top of the head, which run from the eyes to the occiput, are only slightly marked as low, rounded bars. The four spines which in the other *Cotti* mark the beginning and the end of these ridges, are generally replaced in this species by singular structures, which rise in the form of spongeous bony protuberances, two in front, each on the upper posterior margin of the orbit, and two behind on the occiput. These protuberances vary considerably, however, in form and size, but without any fixed dependence on sex or age in specimens at all advanced in growth: during youth, however, they are very indistinct. As a rule, the two anterior ones are the largest, and the two posterior are sometimes much worn or even wanting. They consist of a thin, foliate, osseous disk, which is somewhat bent and at the upper margin widens out into a porous, fungiform knob. The longitudinal distance between them is greater than the transverse, the anterior pair are farther apart from each other than the posterior, and the space between all four is usually more or less rough with small, obtuse, osseous tubercles, which are scattered about in no regular arrangement. Just behind and outside the anterior pair we generally find a small bony spine, which varies in size.

There are four projecting spines on the preoperculum, all fairly large. The uppermost is the longest and is generally turned obliquely upwards and outwards, while the next is directed backwards and outwards, the third backwards and downwards and the lowest downwards and forwards. In most cases the points of all of them project above the skin, but sometimes the points of one or two of them are, as it were, broken off short, nodose or branched. They also vary considerably in direction and length. The opercular spine is almost hidden by the skin, flat and without any roughness whatever. On the suboperculum are 3 or 4 fine, pointed spines, scarcely distinguishable, with the exception of the lowest, which is the longest. On the superior clavicular bones there are also two spines which are broad at the base and rough partly at the point and partly along the upper margin — the lateral line starts from these spines — and on the true clavicular bone a more pointed spine just above the pectoral fin.

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[a] In young specimens there are often only 7 branched rays in the caudal fin: sometimes none of these rays is branched, as is the case in a specimen from Siberia, 137 mm. in length.

The cavernous bones of the face must also in some degree be regarded as a distinguishing peculiarity of this species. This character is, however, easily overlooked when the fish is examined during life or soon after its capture, for the thick, elastic skin conceals the depressions in the bones. It is more distinctly visible when the fish has been dead for some time or has been preserved in spirits. These depressions[a], which belong to the system of the lateral line, occur on the lower side of the lower jaw, three on each side; along the lower margin of the suborbital ring — the chain of bones which forms the lower boundary of the orbit — to a number of four or five; and lastly in the margin of the preoperculum, which has a swollen appearance and in which there are two depressions above the uppermost spine and one in the interval between each pair of spines.

As is generally the case in the *Cotti*, the body tapers in a conical form towards the tail. It shows less lateral compression than in the following species, but is also more elongated and shallower[b]. The lateral line is fairly straight. It consists of raised, oblong scales, concave at the end, and thus acquires a chain-like appearance. With this exception it is completely unarmed, and usually ends a little in front of the base of the caudal fin. Above the lateral line there are generally two irregular rows of scattered, round, somewhat raised and rough scales, which are continued with one or two breaks, now in one row and now in the other, back to the caudal fin. On closer examination these scales show a porous surface, from the raised centre of which radiate small, granulate, bony lamellæ. Similar scales, though of smaller size, also occur in no regular arrangement below the lateral line, where they begin just above the commencement of the anal fin and generally disappear at its end.

The number of the branchiostegal rays varies in this species; it is most often six, but in some specimens five and in others seven.

The dorsal fins are distinct and of ordinary form. The anterior generally contains eight rays; but the number varies between 7 and 9. All these rays are simple, not articulated and somewhat pungent, though more flexible and weaker than in the following species. The posterior dorsal fin generally contains 14 rays, sometimes 13, 15 or 16, all very rough and sharp on each side, articulated but not branched at the tip. In the anal fin we usually find 15 smooth, simple, articulated rays, but the number varies between 15 and 13. The pectoral fins contain from 15 to 17 rays, the 4th and 5th being the longest and the others gradually diminishing in size downwards, to such an extent that the last ray is extremely short, its length being only about $^1/_5$ of that of the first or uppermost ray. All these rays are articulated and undivided, and some of them rough and sharp on each side, in which respect, however, sex generally causes some variation. In the *female* only the first ray is rough on the *inside*, while all the others are smooth; and on the *outside* only the first ray is rough throughout its length, the second from the middle to the tip, the next ones, down to the 5th and 6th inclusive, only at the tip, and all the rest smooth. In the *male*, on the other hand, the first 8 rays are rough on the *outside* throughout their length, and the rest are also armed, when stripped of the thick skin which envelops them; and on the *inside* the first 8 rays are rough at the point, the roughness extending to the middle of the 2nd and 3rd rays and gradually diminishing in extent as we proceed down the fin. The ventral fins contain four rays, the first a hard, spinous ray, which is relatively longer than in the following species of this genus, but is just as closely united as in them to the second ray, which, like the next two (inner) rays, is soft and articulated, but simple at the tip. In the male the innermost ray is often considerably longer than the middle one, in the female of about the same length as it, but to this rule, too, there are many exceptions. The caudal fin is more truncate than in the other species of the genus. Besides the superior and inferior supporting rays, this fin contains 11 other rays. The 8 or 9 middle ones, in old specimens at least, are generally branched, though one may sometimes find specimens from 130 to 140 mm. in length without a single branched ray in the caudal fin. In the male all the simple rays of this fin are generally rough throughout their length, but the branched rays, on the other hand, only from the beginning of the division to the tip: in the female only the uppermost ray is rough. When the caudal fin is folded up, the outer rays are generally those which extend farthest back.

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[a] Cf. *Acerina cernua*, above.

[b] Cf. the above scheme for the distinction of the species of this genus.

On the effects of difference of sex on the external parts of the body we find no remarks in any author before Ekström, although they are very striking. In the *males* the body is generally more cylindrical, and the beginning of the anal fin usually in front of the middle of the body. In these respects, as in several others, the males have retained their position in the juvenile stages of development, which they thus hold in common with the younger females; while we find that in very old males the anal fin sometimes begins a little behind the middle of the body, though not so far back as in females of equal size. The males generally have also higher anal and dorsal fins and longer pectoral and ventral fins. This prevails in some cases, perhaps in most, to such an extent that the rays of the second dorsal fin, when depressed, extend beyond the base of the caudal fin; and it is a rule, to which we have found few exceptions, that in the males the length of the ventral fins is greater than that of the lower jaw. There is also a difference according to sex in the relations of the dorsal fins to each other. In the males the base of the second dorsal fin is generally longer than in the females, but the distance between the beginnings of the two fins is less. Though these two differences are not invariable, the rule holds good if they are combined, — attention being paid to the significance of the above-mentioned changes of growth — that in the males the distance from the beginning of the first dorsal fin to that of the second is less than the length of the base of the latter fin, while in the *females*, except during youth, it is greater. In the latter, too, the belly is more pendent, the anal fin begins behind the middle of the body, and the fin-rays are shorter and not so rough. In the following table we give the most important differences depending on age and sex which we have found in eight females and five males:

	Island-belt of Stockholm SUNDEVALL, Jan., 1857.		Lake Wetter. KALL. November, 1860.	Cape Yakan *Vega-Exped.* September, 1878.	Lake Wetter. KALL. November, 1860.	Lake Wetter. KALL. November, 1860	Morkö EKSTRÖM, January, 1837.	Gothland. LINDSTRÖM, 1852	Lake Wetter HALL. November, 1836	Najtschkaj. *Vega-Exped.* June, 1879	Gothland. LINDSTRÖM, 1852.	Morko EKSTRÖM, January, 1837.	Gothland LINDSTRÖM, 1852	Average in the three youngest females	Average in the last five females.	Average in the five males
	♀	♀	♀	♀	♀	♀	♀	♀	♂	♂	♂	♂	♂	♀	♀	♂
Length of the body in millimetres	73	77	78	137	173	206	218	274	162	170	256	265	272	76.0	201.5	225.0
„ „ „ head in % of the length of the body	30.1	31.2	28.2	29.5	29.4	29.3	29.3	33.2	28.4	30.0	31.2	29.4	30.0	29.8	30.1	29.8
„ „ „ maxillary bones	10.9	11.7	11.1	12.4	12.1	11.9	12.4	15.3	11.7	12.7	14.0	12.1	15.1	11.2	12.8	13.1
„ „ „ lower jaw	15.2	14.5	15.2	16.0	15.0	15.8	14.8	17.5	15.4	14.9	14.8	17.0	17.2	14.9	15.8	15.9
„ „ „ ventral fins	12.3	13.0	11.5	14.6	12.4	10.8	14.4	13.5	19.1	17.1	18.3	17.3	26.1	12.3	13.1	19.6
Least depth of the tail	3.9	4.0	3.8	3.6	4.0	3.9	4.1	3.6	4.3	3.5	4.1	3.8	4.0	3.9	3.8	3.9
Distance from the anal fin to the tip of the snout in % of the length of the body	48.2	48.1	46.1	51.5	50.9	52.1	53.2	55.6	47.2	48.0	47.6	50.0	51.8	47.5	52.7	48.9
Distance from the beginning of the first dorsal fin to that of the second in % of the base of the latter	87.5	95.6	106.4	107.4	110.3	118.5	109.0	110.0	91.2	94.6	94.5	92.6	92.8	96.5	111.0	93.1
Least depth of the tail in % of the length of the longest ray in the anal fin	40.0	47.0	47.6	35.7	46.6	42.1	37.5	34.5	38.8	27.3	28.7	31.8	22.0	44.9	39.3	29.7
„ „ „ „ „ „ „ „ „ „ „ „ „ „ „ „ second dorsal fin	35.0	32.6	36.6	22.7	33.3	30.8	28.1	27.0	19.0	15.4	18.7	21.8	13.3	34.7	28.4	17.6
Length of the ventral fins in % of the length of the belly from the insertion of these fins to the beginning of the anal fin	51.4	54.1	46.4	52.6	44.8	41.3	50.8	46.2	79.5	66.0	73.4	65.7	100.0	50.6	47.1	76.9
Length of the ventral fins in % of the distance from the beginning of the 1st dorsal fin to that of the 2nd	64.3	65.3	54.2	69.0	57.3	46.4	64.3	61.1	100.0	82.8	90.4	81.4	131.5	61.3	59.6	97.2
Length of the ventral fins in % of the distance from the anal fin to the tip of the snout	25.6	27.0	25.0	28.3	24.1	20.7	27.1	24.2	40.5	35.6	38.5	34.8	50.4	25.9	24.9	40.0
Longest ray in the 1st dorsal fin in % of the distance from the beginning of the 1st dorsal fin to that of the second	40.0	50.0	33.7	34.5	41.3	35.4	34.7	40.5	60.0	54.8	55.7	53.0	81.5	41.2	37.3	60.9
Longitudinal diameter of the eyes in % of the length of the head	18.2	20.8	22.7	17.2	23.5	22.8	17.2	12.1	21.0	16.6	15.0	14.7	14.7	20.6	18.6	17.0
Least breadth of the interorbital space in % of the least depth of the tail.	96.4	84.0	66.7	100.0	75.7	87.5	100.0	145.0	57.1	113.3	133.3	114.3	127.3	82.4	101.6	109.1

If it be borne in mind during examination of this table that the average length of the body in the males here measured is greater than in the females, it is clear that in every line in the last three columns where the numbers rise or fall in uniform succession, a distinct change of growth is indicated, and that where this is not the case, an equally distinct sexual difference appears. With respect to the length of the ventral fins in proportion to that of the body, it is true that these three numbers rise uniformly; but here the difference between the last column and the next to the last is so great that the sexual difference is indicated in this way; while, on the other hand, with regard to the length of the maxillary bones and of the lower jaw, the difference between the last column and the next to the last is so slight that we may well suspect that here, too, difference of sex has had some influence, in which case it becomes a rule that the jaws are generally longer in the females than in the males. The table also suggests that the long and low form of the body, which is so characteristic of the species, expressed in the ratios of the least depth of the tail, and the relatively small eyes are most strongly marked in the two specimens from the frozen sea of Siberia, where, to judge by this circumstance, the species attains its most perfect typical character.

The colouring of the Four-horned Cottus is much duller than that of the two following species, and thus contributes to render its appearance still more repulsive. The back and the upper part of the head are grayish brown, in some specimens finely marbled with dark spots, which are partly coalescent. The sides are lighter and towards the belly shade into light brownish yellow with a brassy lustre. In the male the same colour, with a dash of red, extends over the belly as well; but in the female the belly is white. The round, rough scales on the sides of the body are yellowish white. The iris is dark flame-yellow, lighter at the inner margin.

The internal structure of the Four-horned Cottus is essentially the same as that of the other species of the genus, but is different in some respects. The liver, the breadth of which is greater than its length, lies across the abdominal cavity and extends slightly farther back on the left side than on the right. The pyloric appendages, which are arranged in a wreath round the pylorus, are comparatively short and only from 6 to 8 in number. The longest of them is situated on the side next to the stomach; the others gradually diminish in size. In this species, too, the ovaries are really united into one, but this is more deeply cloven into two lobes. According to Sundevall the colour of the roe varies between dark brown and dark or light green.

The geographical range of the Four-horned Cottus is extremely singular and instructive. It is wanting, to the best of our knowledge, on the west coasts of Scandinavia[a] and Greenland, as far north as the Danish colonies extend[b]; but on the east coast of Greenland it was taken by the German "North Pole Expedition" of 1869—70[c]. In Spitzbergen it has not yet been found, but in the White Sea it was taken in 1861 by the Finnish naturalist Selin, and Lieutenant Sandeberg brought home to Stockholm numerous specimens from the neighbourhood of Archangel. Even Pallas (l. c.) stated that the Four-horned Cottus is not only an inhabitant of the coasts of Kamchatka, but is also of common occurrence in fresh water in Siberia, as, for example, in Lake Baikal and other lakes, and also in the rivers flowing from these lakes all the way to the Arctic Ocean, where it was found, on the coast of Siberia, by the Vega Expedition. It was from Coppermine River, in the middle of the extreme north of North America, that Richardson obtained his *Cottus hexacornis*, which he subsequently proved to belong to the same species as the Four-horned Cottus; and during Captain Feilden's expedition Mr. Egerton found a small Four-horned Cottus dead on the shore of Dumbell Harbour in latitude 82$^{1}/_{2}$° N. — "No other salt-water fish," says Günther[d], "is known at present to have been found at a higher latitude."

In Sweden, until the publication of the first edition of this work, the Four-horned Cottus had been regarded exclusively as a salt-water fish. Ekström and Fries were then able to show that it occurs in fresh water in Scandinavia also, "probably in several localities, though as yet we have had time to trace it only in Lake Wetter." It has subsequently been obtained by EKSTRÖM from Lake Wener as well[a]. For the first-mentioned discovery we have to thank Sergeant-major HALL of Grenna, who in 1836 forwarded to the Royal Museum several specimens of this fish, taken during the spawning-season. The Four-horned Cottus of Lake Wetter differs, however, in some respects from that of the Baltic and the Arctic Ocean.

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[a] According to information given by Baron Gyllenstjerna to Nilsson (l. c.), it has been taken off Kullen, but it has never reappeared there. According to Günther (l. c.), Gray once obtained a fresh specimen at Billingsgate, which was perhaps a stray individual that had wandered into the North Sea. Malm (l. c.) obtained a specimen from Nordre River, six miles from its mouth, which had presumably come down the stream from Lake Wener.

[b] Cf. Lütken, l. c., p. 376.

[c] *Die Zweite Deutsche Nordpolarfahrt*, Bd. 2, p. 169. (Peters.).

[d] Proc. Zool. Soc. 1877, p. 293.

The Four-horned Cottus of Lake Wetter — or "*simpa*", as it is called there and very often in the island-belt of Stockholm — is of smaller and more slender shape, being at most about 210 mm. in length. The body is strewn with smaller and fewer sharp scales on the sides, and in the female is often scaleless below the lateral line. The eyes are large, their longitudinal diameter (see the table above) varying between 23 and 24 % of the length of the head, whereas this ratio in specimens of equal size from the Baltic or the Arctic Ocean varies between 17 and, at most, 21 %. The distance between the eyes is also less, the least breadth of the interorbital space in the three females from Lake Wetter mentioned above — which are on an average 152·3 mm. in length — being on an average only 76·6 % of the least depth of the tail; while in the other females, the average length of which is 155·8 mm., this ratio rises on an average to 105·1 %, and even in the four youngest of the latter, the average length of which is 126·5 mm., to 95·1 %. Of the four protuberances on the top of the head we find only the rudiments, consisting of small, low, obtuse, bony spines, which are most often, however, furnished with several points, exactly as in young specimens from the Baltic. To judge by specimens preserved in spirits, the colouring also seems to be much paler. According to Mr. HALL'S account this variety is common in Lake Wetter, and spawns there in November, in deep water and on a clayey bottom. It is not eaten. Its food consists of insects and small fresh-water crustaceans, among which it also finds its favourite morsel, the fairly large *Idothea entomon*, also a relic of the Glacial Period. The contents of its stomach also show that it greedily devours the deposited roe of other fishes. MALMGREN and S. LOVÉN have proved that a similar variety of the Four-horned Cottus occurs in Lake Ladoga; and the latter has founded on this find and several others of a like nature his brilliant theory as to the post-glacial history of Lake Wetter and several other Scandinavian lakes. They carry us back to a time when the Arctic Ocean extended southwards from the White Sea across Finland till it joined the Baltic, which in its turn spread westwards over the districts surrounding Lakes Wetter and Wener. This is his explanation of the fact that the Four-horned Cottus, together with a number of crustaceans, has become an inhabitant of these lakes, as a survivor from a prehistoric Arctic Fauna.

On the Swedish coast of the Baltic the Four-horned Cottus is most common in the middle portion, especially in the inner island-belts of Stockholm, both the northern and the southern. Its range extends south at least as far as Gothland. It also occurs occasionally even on the coasts of Prussia and Pomerania[b]. In the north it is found along the coast of Norrland, and also inhabits the Gulf of Finland. Its way of life probably differs in no important respect from that of the Sea Scorpion; and both these species are often met with together, though the Four-horned Cottus is more strictly a shore-fish and apparently does not occur so far out at sea as the other species[c]. Its food seems chiefly to consist of the crustaceans common in the Baltic, especially the large *Idothea entomon*, with which one generally finds its stomach filled, and also of mollusks and insects, seldom of small fishes. The spawning-season occurs in November, December and January, in the Baltic on a stony bottom. The roe is deposited, says SUNDEVALL, like that of the Perch, in one single mass; but this is attached to the bottom in water of some depth, possibly even several fathoms. In a piece of roe which Baron CEDERSTRÖM found in a seine, the young were hatched during the latter half of April. They were then about 11 mm. in length, and their external and internal organs were far more developed than is generally the case in the fry of other fishes. They swam about freely, but soon sought shelter in the roe from which they had emerged.

It is during the spawning-season that most of these fish are taken in nets, which are called *Simpnät* (Cottus-nets). For this purpose old, discarded Perch-nets, Roach-nets etc. are used. It is also taken with tackle called *pimpeldon*, which consists of a bright piece of tin as long as one's finger, to the lower end of which four hooks are fastened in a cross. This is attached to a line which is sunk to the bottom and plucked up and down without a stop, as in bobbing (*pimplande*) for Herrings. This fish is also speared with small leisters by torchlight, and sometimes taken in nets or seines shot for other fishes.

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[a] See MALM, l. c.

[b] Cf. MÖBIUS and HEINCKE, l. c.

[c] Cf. SUNDEVALL, l. c., p. 86.

The Four-horned Cottus is considered the most eatable of the whole genus. Though the flesh has a peculiar smell, which is not agreeable to all tastes, it loses this when rightly prepared, and acquires a fairly pleasant flavour. The liver is held in the highest esteem. In Stockholm this fish is regarded by many as a great delicacy. It therefore often appears in the market. It is then always skinned, and the head removed. SUNDEVALL calculated the annual value of this fishery between 1850 and 1860 at about 2,000 Swedish crowns (£110). In this estimate, however, the Sea Scorpion is also included.

(EKSTRÖM, SMITT.)

THE SEA SCORPION OR SHORT-SPINED COTTUS (SW. RÖTSIMPAN).

COTTUS SCORPIUS.

(Plate VIII, figs. 2 and 3).

Top of the head with spines and ridges. Preopercular margin with 3 or 4 spines. Lateral line without spines, generally with a very distinct, downward curve at the end of the second dorsal fin. Length of the maxillary bones generally greater in the female than in the male (at least after the time when the external difference of sex appears) and varying between 47 and 58 % of the base of the second dorsal fin: the length of the lower jaw, which differs in the same way according to sex, varying between 57 and 68 % of the base of the same fin. Least depth of the tail more than $4^1/_2$ % of the length of the body, and varying between 24 and 33 % of the base of the anal fin. Margins of the branchiostegal membranes united by a free dermal fold across the isthmus. No dermal fringes on the maxillary bones. Number of rays in the second dorsal fin generally more than 14, in the anal fin generally more than 11.

R. br. 6; *D.* 9^a–11 | 14^b–17; *A.* 11^c–14; *P.* 16^d–18; *V.* $^1/_3$; *C.* $x+7$–$9+x$; *L. lat. por.* 37—43.

Syn. *Cottus* alepidotus; capite polyacantho; maxilla superiore paullo longiore, ART., *Gen. Pisc.*, p. 49; *Syn.*, p. 77; *Spec.*, p. 86.

Cottus Scorpæna, LIN., *Mus. Ad. Frid.*, vol. I, p. 70.

Cottus Scorpius, LIN., *Syst. Nat.*, ed. X, tom. I, p. 265; *Fn. Suec.*, ed. II, p. 115; FABR., *Fn. Groenl.*, p. 156; RETZ., *Fn. Suec. Lin.*, p. 328; PALL., *Zoogr. Ross. Asiat.*, vol. III, p. 130; CUV., VAL., *Hist. Nat. Poiss.*, vol. IV, p. 160; EKSTR., Vet.-Akad. Handl. 1831, p. 312; NILSS., *Prodr. Ichth. Scand.*, p. 96; FRIES, EKSTR., WRIGHT, *Skand. Fisk.*, ed. I, p. 23, tab. 5; KRØY., *Danm. Fiske*, vol. I, pp. 130 et 583; NILSS., *Skand. Fn.*, *Fisk.*, p. 68; GTHR, *Cat. Brit. Mus.*, *Fish.*, vol. II, p. 159; MGRN, *Finl. Fisk.*, p. 6; *Spbg. Fisk.*, Öfvers. Vet.-Akad. Förh. 1864, p. 495; LINDSTR., *Gotl. Fisk*,, Gotl. L. Hush. Sällsk. Årsber. 1866, p. 14 (sep.); COLL., Vid. Selsk. Forh. Christ. 1874, Tillægsh., p. 24; LTKN, Vid. Meddel. Naturh. For. Kbhvn 1876, p. 370; MALM, *Gbgs*, *Boh. Fn.*, p. 388; WINTH., *Zool. Dan.*, *Fiske*, p. 8, tab. II, fig. 1 et 2; Naturh. Tidskr. Kbhvn, ser. III, vol. XII, p. 9; COLL., Norsk. Nordh. Exped., Zool., Fisk., p. 25; DAY, *Fish. Gt Brit.*, *Irel.*, vol. I, p. 49, tab. XIX, fig. 1, tab. XX, fig. 1; LILLJ., *Sv.*, *Norg. Fisk.*, vol. I, p. 135; MOREAU, *Hist. Nat. Poiss.*, *Fr.*, vol. II, p. 298; MÖB., HCKE, *Fisch. d. Ostsee*, p. 43; JORD., GILB., Bull. U. S. Nat. Mus., No. 16, p. 702.

Cottus groenlandicus, CUV., VAL., l. c., p. 185; RICHARDS, *Fn. Bor. Amer.*, pt. III, pp. 46 et 297, tab. 95, fig. 2; DEK., *N. Y. Fn.*, *Fish.*, pt. IV, p. 54, tab. IV, fig. 10; GTHR, l. c., p. 161; GILL, Proc. Acad. Nat. Sc. Philad., 1872, p. 213; JORD., GILB. (subsp.) l. c., p. 703.

Cottus porosus, CUV., VAL., l. c. vol. VIII, p. 498; *Cottus* (*Acanthocottus*) *variabilis* (AYRES), *labradoricus* (GIRARD), *ocellatus*, STORER, Journ. Bost. Soc. Nat. Hist. vol. VI, pp. 248 et 253. *Cottus glacialis*, RICHARDS., *Voy.* BELCHER, vol. II, p. 349, tab. 24. De his synon. vide MGRN, l. c.

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[a] Sometimes 7 or 8, according to LÜTKEN.

[b] Sometimes 13 or even as many as 19, according to LÜTKEN.

[c] Sometimes only 9, according to DAY, or 10, according to LÜTKEN; sometimes 15, according to the latter.

[d] Only once have 15 been found, according to LÜTKEN. NILSSON, however, gives from 15 to 17.

The Sea Scorpion is one of the most variable forms and has therefore, not without reason, borne many systematic names. The merit of referring all the specific names given in the above list of synonyms to one single species, was first gained by Professor MALMGREN in his excellent revision of "The Fishes of Spitzbergen." Besides the various forms which appear within the limits now accepted for the species, we find several other forms which cannot be included within these limits, but which, either as intermediate forms or by their changes of development, range themselves so close to *Cottus scorpius* that natural series may be traced in one direction to the genus *Cottunculus*, in another to *Cottus quadricornis* and in a third to the more nearly Scorpænoid *Cottus bubalis*. One of these intermediate forms we find in the Siberian *Cottus platycephalus*[a], which by *Cottus tæniopterus*[b] and *Cottus Brandtii*[c] is united to *Cottus scorpius*, but by its small eyes, the great breadth of the interorbital space and the long lower jaw, which projects beyond the tip of the snout, guides us to the transition to *Cottunculus*, and again is referred by the low tail to that group of the genus of which *Cottus quadricornis* is the best-known representative. From this group *Cottus scorpius* itself forms the transition to the *bubalis* (*Enophrys*) group.

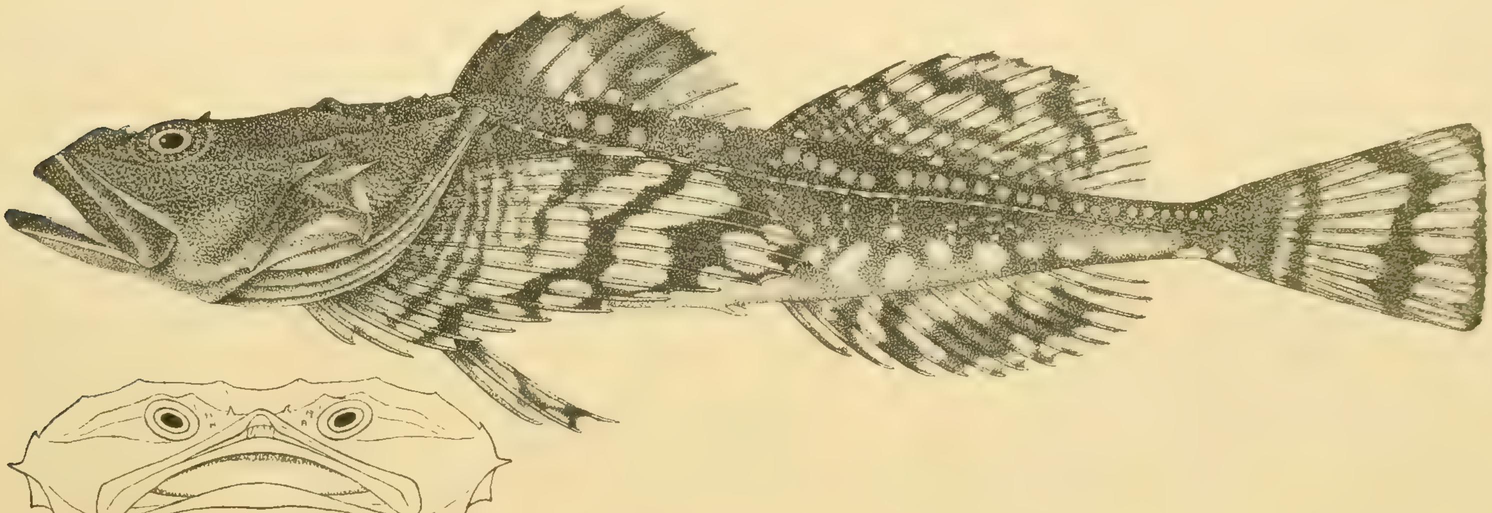

Fig. 53. *Cottus platycephalus*, Najtschkaj, 10th April, 1879. Vega Expedition. Natural size.

The Sea Scorpion — as in some respects the following species — thus stands at the centre, so to speak, of the developmental range of the family, with branches in several directions; and its varieties of form gain greater importance, the more fully we are able to explain the circumstances from which they have arisen. MÖBIUS and HEINCKE have given[d] the following list of the changes of form which occurred in about 300 specimens examined by them and taken in the south-west of the Baltic. The largest of these specimens were 300 mm. in length.

229	specimens	(84 %)	had only 3 spines in the preopercular margin,
28	,,	(10 %)	had 4 spines in the preopercular margin on one side of the body,
17	,,	(6 %)	had 4 spines in the preopercular margin on each side of the body,

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[a] PALLAS: *Zoogr. Ross. Asiat.*, tom. III, p. 135: but without palatine teeth and with the fin-formula: $D.\ 9\ 15;\ A.\ 13;\ P.\ 16;\ V.\ ^{1}{}_{3};\ C.\ x+7+x$. This is the form in which this species appears in the collections of the Vega Expedition from Najtschkaj (the extreme north-east point of Siberia) — cf. the Catalogue of the Swedish Department of the Fisheries Exhibition in London 1883, p. 174. It thus does not tally with the description given by PALLAS, to which KNER'S *Cottus tæniopterus* perhaps answers better. As PALLAS states, however, that his species is common in these regions, and as it would appear never to have been found again by later explorers, there seems to me to be very little danger in employing his name, which is at any rate most suitable for this species.

[b] KNER, Stzber. Akad. Wiss. Wien. Math. Naturw. Cl., LVIII, I (1868), p. 310, pl. IV, fig. 10.

[c] STEINDACHNER, ibid., LV, I (1867), p. 706, pl. III, figs. 1 and 2.

[d] *Fische der Ostsee*, p. 44.

6 specimens (2 %) had an extraordinarily short head,
6 ,, (2 %) were very nearly short-headed,
10 ,, ($3^1/_2$ %) had the ridges and protuberances of the head very strongly marked (transition to *Cottus bubalis*),
4 ,, ($1^1/_2$ %) had the ridges and protuberances of the head extremely little developed and also covered by the skin (transition to *Cottus gobio*),
2 ,, ($^7/_{10}$ %) had very short preopercular spines, almost covered by the skin (transition to *Cottus gobio*),
7 specimens ($2^1/_2$ %) had the longest preopercular spine branched at the tip or furnished with small lateral spines (transition to *Cottus dicerans* and *ventralis*),
6 ,, (2 %) had an irregular arrangement of ridges on the head.

If we now endeavour to find an explanation of the cause of similar changes of form, we obtain the clearest indications, here, as in other cases, by following the course of the changes due to age and investigating the expression of the external sexual differences, while this species also affords singular proof of the appearance of different characters in different geographical environments. The following table is calculated to give information on these points:

	Cottus scorpius.												*Cottus platycephalus.*	
	Average in 3 specimens from Bohuslän.	Average in 5 specimens from Spitzbergen.	Spitzbergen, Mossel Bay, May, 1873.	Outer island-belt of Hudiksvall, Nov. 1882.	Bohuslän, July, 1835.		Spitzbergen, Hornsund, July, 1864.		The Baltic.		Greenland, Ivigtut Aug. 1883.		The winter-quarters of the "Vega," 1879	
									Mörkö, Jan., 1857.	Outer island-belt of Hudiksvall, Nov., 1882.			$^{29}/_3$.	$^{26}/_6$.
			♂	♂	♀	♂	♀	♂	♂	♀	♀	♀	♂	♂
Length of the body expressed in millimetres	96.5	101.2	150	149	189	189	201	204	201	227	299	310	211	255
,, ,, ,, head in % of the length of the body	33.5	32.3	33.3	33.5	36.0	36.0	32.8	32.6	34.3	34.3	33.8	32.9	31.5	30.6
,, ,, ,, maxillary bones ,, ,, ,, ,, ,, ,, ,, ,,	12.9	13.1	13.6	13.4	14.8	14.3	14.6	13.2	12.9	14.5	14.7	14.7	12.3	12.1
,, ,, ,, lower jaw ,, ,, ,, ,, ,, ,, ,, ,,	16.1	15.9	16.0	16.6	18.0	18.0	17.1	16.4	16.1	16.7	16.7	17.3	19.2	18.8
Longitudinal diameter of the eyes ,, ,, ,, ,, ,, ,, ,, ,,	7.6	7.0	6.3	7.4	6.9	7.4	5.2	5.4	7.4	6.1	5.0	5.1	4.3	3.9
Breadth of the interorbital space ,, ,, ,, ,, ,, ,, ,, ,,	3.7	4.4	4.1	4.1	4.2	4.7	4.4	4.7	3.9	4.4	4.3	4.4	7.1	7.8
Least depth of the tail ,, ,, ,, ,, ,, ,, ,, ,,	5.3	5.2	5.3	4.7	5.5	6.1	4.9	5.4	5.4	5.2	5.7	5.5	3.9	4.3
Distance between the first dorsal fin and the tip of the snout ,, ,, ,, ,, ,, ,, ,, ,,	30.0	30.0	30.0	30.2	30.8	31.7	32.1	29.9	30.3	30.6	32.1	32.2	30.0	27.8
Distance between the beginning of the first dorsal fin and that of the second ,, ,, ,, ,, ,, ,, ,, ,,	20.0	20.2	19.6	20.8	20.9	18.5	21.7	21.5	19.2	20.7	23.7	23.2	20.5	22.3
Base of the second dorsal fin ,, ,, ,, ,, ,, ,, ,, ,,	24.9	25.7	25.5	26.8	26.1	26.4	25.2	26.0	27.6	27.3	26.7	27.4	28.9	25.5
,, ,, ,, anal fin ,, ,, ,, ,, ,, ,, ,, ,,	17.6	19.9	18.6	17.4	19.6	19.7	19.4	18.1	18.9	17.7	17.0	17.7	24.6	22.7
Length of the ventral fins ,, ,, ,, ,, ,, ,, ,, ,,	16.5	16.2	19.3	18.4	17.4	18.2	15.9	20.8	20.3	15.0	16.7	16.4	19.9	18.4
Distance between the insertion of the ventral fins and the beginning of the anal fin ,, ,, ,, ,, ,, ,, ,, ,,	25.7	24.7	24.6	25.2	26.4	25.7	28.6	25.0	25.2	29.5	26.7	27.7	27.5	28.2
Distance between the beginning of the anal fin and the tip of the snout ,, ,, ,, ,, ,, ,, ,, ,,	51.2	51.0	52.0	51.3	53.6	54.2	54.7	52.4	53.2	54.6	50.8	54.8	52.1	52.3
Length of the pectoral fins from the upper end of the base ,, ,, ,, ,, ,, ,, ,, ,,	20.8	20.7	22.0	21.4	22.7	21.7	19.9	22.5	22.0	21.1	21.4	21.6	26.0	23.9
Length of the pectoral fins from the lower end of the base ,, ,, ,, ,, ,, ,, ,, ,,	30.1	29.8	30.0	31.5	31.2	30.0	30.8	30.4	31.3	30.8	32.1	30.0	37.4	36.1
Length of the maxillary bones in % of the base of the second dorsal fin	52.4	51.2	53.5	50.0	56.0	54.0	58.1	50.9	46.8	53.2	55.0	53.5	42.6	47.7
,, ,, ,, lower jaw ,, ,, ,, ,, ,, ,, ,, ,, ,, ,,	65.8	62.2	62.6	59.2	68.0	68.0	67.9	63.2	58.5	61.1	62.5	62.3	66.6	73.9
Least depth of the tail ,, ,, ,, ,, ,, ,, ,, anal fin	30.2	26.2	28.6	27.0	28.4	30.8	25.6	30.0	29.0	29.5	33.3	30.9	15.6	19.0
,, ,, ,, ,, ,, in % of the distance between the insertion of the ventral fins and the beginning of the anal fin	20.7	21.0	21.6	18.6	21.0	22.6	17.4	21.5	21.7	17.6	21.2	20.0	14.0	15.2
Longest ray of the first dorsal fin in % of the distance between the beginning of the first dorsal fin and that of the second	51.9	49.1	57.6	55.0	48.1	55.1	53.5	72.7	72.5	56.4	59.1	58.3	52.0	54.4

With age come distinct changes in the length of the head and of the jaws, which become larger, even in relative size; in the distance between the beginning of the first dorsal fin and that of the second, and in the distance between the former and the tip of the snout, both of which measurements also increase; in the distance between the ventral fins and the beginning of the anal fin and in that between the latter and the tip of the snout, which also increase; and lastly in the longitudinal diameter of the eye, which, on the other hand, diminishes with age according to the rule. In the length of the head scarcely any sexual difference can be detected; but in all the rest of these changes of growth the females take the higher place in the scale of development. The most constant external difference between the sexes, the length of the ventral fins, naturally becomes more marked with age. It may be expressed, at least in specimens 150 mm. or more in length, as follows: in the males it is more, in the females less, than 18 % of the length of the body, or 85 % of the distance between the beginning of the first dorsal fin and that of the second, or 33 % of the distance between the anal fin and the tip of the snout. Geographical separation, according to the above table, seems to be accompanied also by an increase in the length of the head in the specimens from Bohuslän and the Baltic, but shows its influence most clearly in the size of the eyes, the longitudinal diameter of which, in spite of the great changes due to age, is distinctly larger in specimens from more southern latitudes than in those from the Arctic regions. We must here add an observation made by Malmgren, given also by Day[a], that the Scandinavian specimens generally have a larger number of rays (usually 2 more) in the first dorsal fin than those which live further south. It has also been ascertained, says Lütken[b], that the Arctic Sea Scorpion, as a rule, has 39 (in exceptional cases 36) vertebræ, while the European variety has only 34[c] or 36[d]. In other fishes, of less variable form, these differences would certainly have been considered great enough to constitute specific characters — here we see them dependent on differences of age, sex or locality. According to Day the species has “an evident tendency to degenerate the further it is from the Arctic region”, but from a systematic point of view this “degeneracy” indicates a transition to the *bubalis* group. In the number of the vertebræ *Cottus scorpius* occupies an intermediate position between *Cottus quadricornis*, which has 40, and *Cottus bubalis*, which has only 29 or 30. The variability of the Sea Scorpion thus suggests without ambiguity an explanation of the origin of its kindred species. The course of development stops at different stages, has its direction fixed by a sexual character, or bears the stamp of different external influences due to different local circumstances.

The usual size of the Sea Scorpion in Scandinavian waters is between 200 and 250 mm. In the Baltic and the Cattegat it seldom exceeds the latter measurement; but on the coast of Norway it grows somewhat larger, and in the Arctic regions it is said to attain a length of about 600 mm[e]. The length of the head (cf. the above table) is about $^1/_3$, its depth about $^1/_5$, of the length of the body. The breadth of the head varies considerably, and depends on the greater or less expansion of the gill-cover, which causes a great alteration in the appearance of the head. The gape is large, and the upper jaw somewhat projecting; it is moved chiefly by the help of the intermaxillary bones, which are rendered capable of some protrusion by their nasal process. They are covered by the labial skin, which is, as it were, rolled over them. Fine, cardiform teeth are closely set in the lower jaw, on the intermaxillary bones and on the head of the vomer, where they are arranged in a right angle pointing forwards. There are no teeth on the palatine bones or the tongue; but in the pharynx, above and below, we find two round patches, close to each other and covered with similar teeth. The upper pair of patches are larger, more perfectly round and set almost in the same plane; the lower are smaller, flatter and set in different planes, together forming a right angle in an upward direction. Of the four branchial arches on each side the first three are completely free, the fourth generally united throughout its length to the back wall of the branchial cavity by a membrane behind it, which sometimes, however, leaves an opening free. The gill-rakers appear in the form of verrucose, spinous, bony protuberances; the branchial lamellæ are thin and low. The branchiostegal membrane, which is supported by six rays, is united under the middle of the throat (the isthmus) to the corresponding membrane on the other side by a continuation of its skin, which is here of almost the same breadth as itself, and has an even, transverse margin, posteriorly free. When both the branchiostegal membranes are expanded, there thus appears a large arcuate collar round the head. The nostrils are small, forming on each side two funnel-shaped, dermal ducts, which are separated by the nasal bone, the one opening lying on the side of and close to the anterior margin of the eye, the other in front of the latter and somewhat nearer it than the tip of the snout. The eyes (cf. the above table) are fairly large — their longitudinal diameter varies between $^{2}/_{9}$ (in young specimens) and $^{1}/_{7}$ (in old) of the length of the head — and so close together that the space between them, which is concave, is narrower than their diameter. The pupil is round; in some specimens oval, with the more pointed end directed forwards. The head is armed with several spinous processes — first with two, pointed, conical spines in front of the eyes and between the nostrils, projecting from the sides of the nasal bone and movable; and secondly with four fixed spines on its top, which point in a backward direction, one at the superior margin of each eye and one on each side, at the end of the occiput. Between the latter runs a bar on each side of the top of the head, that on one side being nearly parallel to that on the other. The four last spines, which look like small horns, have given rise to the name of *Hornskalle* (Hornhead). Sometimes they are wanting, and in their stead we find more or less sharp tubercles. The fishermen hence believe that these horns are shed or knocked off in some way during the spawning-season. On the margin of the preoperculum we generally find three (sometimes four) strong spines. The uppermost is the largest and points in a backward direction; it never extends so far back, however, as the opercular spine, which points in the same direction as it. The second is next to it in size and also directed backwards: sometimes the tips of both project above the thick skin which covers them. The other two are short and flat; the fourth points downwards and the third is often wanting, or present on one side of the body and wanting on the other. The operculum ends in a long, projecting spine (the opercular spine) and a still longer, thin, dermal margin. The suboperculum has two spines in its lower margin; the one points downward and is the longer, the other is turned inwards in a forward direction and is hidden by the preoperculum. The interoperculum, as usual, has its upper posterior corner prolonged into a spine, which is directed backwards, but is scarcely visible, as it lies under the point of the downward spine of the suboperculum. There is also a long spine, which lies under the skin and is directed backwards, on the true clavicular bone, and a similar one on the upper clavicular bone. The lateral line is raised, but totally unarmed. It lies near the back, and follows the dorsal curve to the end of the second dorsal fin, at about the 30th pore in the line counted from the beginning, where it curves slightly downwards and then terminates at the middle of the base of the caudal fin. On each side of the line are scattered irregularly strewn, stiff scutes, of a singular nature, generally differing in the different sexes. In the male they are large, flat, rounder, depressed at the centre and cup-shaped, with from 3 to 5 or more stiff points, turned outwards in a backward direction or set in the margin of the whole scute; in the female they are smaller and narrower, nearly oblong, with only 1 or 2 spines. In the latter sex, too, they are not always present, for one may find specimens entirely without them, others with extremely few, and so forth. The body tapers conically towards the tail and is rounded, with the caudal part laterally compressed to some extent. The back, which rises somewhat to the 3rd fin-ray and then slopes evenly towards the tail, has its two fins quite distinct, but often set very close together. The first dorsal fin is more convex, shorter and lower than the second; its two first rays are usually close together at the base. In Scandinavian specimens the number of rays varies between 8 and 10, all simple, pungent and curved slightly backwards; in Arctic specimens it is most often 11. The posterior dorsal fin is larger, with rounded margin, and in Scandinavian specimens contains from 14 to 16, in Arctic often 17 and sometimes even 19, simple, articulated and weak rays. The pectoral fins are large, as is the rule in the genus, oblong and rounded, with from 15 to 17 simple, articulated, round and thick rays. The 7th and 8th rays are the longest, and the fin then sharply diminishes in length to the last ray, the length of which is only $^{1}/_{2}$ or $^{1}/_{3}$ of that of the first (uppermost) ray. As is generally the case in the genus, the tips of the lowest rays extend somewhat beyond the fin-membrane. The ventral fins are long (cf. the above table), narrow and of almost uniform breadth; they are set below the pectoral fins, and consist of one, short, spinous ray and three, longer, soft rays, the middle ray being generally the longest. The spinous ray, which is closely united to the first soft ray and hidden by the skin, may easily escape notice, but is mentioned even in Artedi. The anal fin contains from 11 to 14 rays, generally 12 or 13, which are similar to those of the second dorsal fin. The caudal fin is rounded and contains 11 or 12 rays, from 7 to 9 of the middle ones bifid at the tip. Behind the vent is a small, conical papilla, larger, as usual, in the male than in the female.

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[a] *Fishes of Great Britain and Ireland*, vol. I, p. 50.

[b] Vid. Meddel. Naturh. For., Kbhvn 1876, p. 373.

[c] Moreau, *Poiss. Fr.*, Tome 2, p. 299.

[d] Malm, *Gbgs. Boh. Fn.*, p. 389.

[e] Pallas, l. c. Möbius and Heincke state that it attains as great a length as 1 metre.

The difference between the sexes is often so great that the fishermen of the middle portion of the island-belt on the east coast of Sweden regard them as two distinct kinds of fishes. The *male* generally has a more slender body and higher fins, to which we may add the spinous scutes described above and the remarkable character which consists in the arming of the inside of the rays of the pectoral and ventral fins with a row of sharp teeth, beginning about half-way along the rays and continued almost to the point. The *female*, on the other hand, usually has a more bulky body and shorter fins, especially the ventral (cf. the above table), while the scales of the body, as we have remarked above, are either wanting or, at least, are fewer and smaller: the teeth on the pectoral and ventral rays are also wanting. The difference between the sexes, however, is not confined to the form alone; there is a still more marked distinction between them in the coloration, which in the Sea Scorpion also varies considerably with age, the season of the year and the environments of the fish. The coloration also changes suddenly when the fish is drawn out of the water, and it is hard for anyone who has not seen a new-caught Sea Scorpion during the spawning-season, to realise the blending of brilliant colours which adorns this fish, in other respects so ill-favoured. Plate VIII, fig. 2 represents a male, fig. 3 a female, of this species[a], but in neither figure does their handsomest dress, that of the spawning-season, appear, but that which they generally wear in the Baltic. It is easy, however, to gain from these figures an idea of the colouring in the spawning-season, when we remember that the colours then become deeper and purer and their boundaries more sharply defined. The red belly of the male, its most distinguishing point, acquires a bright red colour with a coppery lustre, forming a sharp contrast to the silvery, drop-shaped spots. In the female yellow, shading into gold and with more distinct variegations, becomes the predominant colour. It must not be supposed, however, that all the spots and bands given in the figures are constant in number, form and position, for they vary considerably in all three respects.

The digestive canal is made up of a short, but wide, œsophagus, which gradually widens into a muscular stomach, the sac being very distinct. From 8 to 10 appendages, of about the same length, are wreathed round the pylorus and extend to the end of the stomach. The intestine, which is very thin and fragile, forms three curves before it opens into the vent. The liver strictly consists of one, large, thick lobe, which is situated on the left side. It is yellowish brown in colour, and the gall-bladder is small. The spleen is small and chestnut-brown. There is no trace of an air-bladder. The ovary is divided at the point into two lobes with round corners, and contains, for some weeks previously to the depositing of the spawn, red eggs of the size of a grain of mustard. There are two testes, the right one being much the larger, of a yellowish white colour, marbled with more or less blackish blue. The urinary bladder is fairly large and also divided at the bottom into two lobes of different size.

The most common name of the Sea Scorpion among the fishermen of the Sound and the Cattegat is *Ulk*, but it has also many others among the islands of the Baltic, e. g. *Skrabb*, *Vildkråks-simpa* (Wild-crow Cottus), *Hornskalle* (Horn-head), *Skinnskrabba* (Skin Cottus), *Skälryta* etc. It lives only in salt water, and is found on both sides of Scandinavia, from the extreme north of Norway down to the Sound, and then along the island-belt of the Baltic at least as far north as Uleåborg in Finland, according to Malmgren. As we have remarked above, however, it is in all respects most highly developed in the Arctic seas, which must, therefore, be regarded as its true home. It has long been known in Greenland and Spitzbergen. Pallas assigned it to Siberia; but his statement was doubted until the Vega

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[a] These figures and Ekström's description were published, as is known, long before Gill (l. c.) published his observations on the sexual difference in the coloration. Cf. Day, l. c. But even in Fabricius (*Fn. Grœnl.*, p. 156) we find: — "maris venter flavus, albomaculatus."

Expedition[a] brought home specimens from the northernmost parts of that region. It also occurs to the south, though it is there "degenerate", as far as the west coast of France, and on the American coast as far as New York.

This species is one of those that may be called migratory. It moves from one place to another along the coast of the sea which it inhabits, occurring in considerable quantities at a certain spot for some years and then suddenly diminishing in number, not to reappear in any abundance until after the lapse of ten or twenty years. It occurs in water of no great depth, where the bottom consists of clay or stones overgrown with seaweed. Except during the spawning-season it leads a solitary life and always keeps close to the bottom. It passes the hours of daylight in dark crevices, awaiting the approach of some victim. It is due to its sluggish disposition that it spends the greater part of its existence in idleness and solitude. Rashness and voracity are the other chief traits of its character. In the latter respect it is surpassed by few, if any, fishes. Three Roach, each nearly 100 mm. long, have been found in a Sea Scorpion 220 mm. in length. Its timidity is so slight that, when touched, it only makes a leisurely movement to avoid the object that has disturbed it, and soon stops, as still as if nothing had happened. If it is caught, as often happens at "*torskning*" (fishing with hand-lines for Codlings), and then marked in a way sometimes employed by the fishermen, by cutting away a part of one of its fins, and again dropped into the water, after a few minutes it is ready to take the same hook and submit to the same operation. Though so little sensitive, still it is not remarkably tenacious of life. When drawn out of the water, it wriggles a few times in its efforts to get free, and, not succeeding in this, seems quite indifferent to its fate, seldom showing any marked sign of life, even though it is still alive. It seems to grow quickly, for small specimens are rare. In Sweden it probably does not propagate its species until it has attained a length of about 150 mm.; no smaller specimens, at least, occur at the spawning-place. Its movements in the water are speedy but not prolonged, and the winding curves, like those of an Eel, in which its body moves, are apparently the result of considerable exertion. The great size of its fins does not contribute greatly to the speed of its movements, but seems rather intended to maintain the equilibrium of its bulky and unwieldy body. Its food consists chiefly of other fishes, though, especially in winter, when the supply of fish is scanty, it does not despise crustaceans, worms and mollusks. The spawning-season begins in December and lasts through the winter; but as early as the beginning of October these fishes begin in large shoals to approach those parts of the coast where the bottom consists of sand, here and there overgrown with seaweed. The males and females are then in company, but the former are so greatly in the minority that one scarcely finds one male to ten females. The latter come nearer shore than the males, which extremely seldom occur at the place where the roe is deposited. We might here find grounds for the conjecture that the roe is fertilized before its deposition, and that there is some closer commerce between the sexes out at sea. In this case the serrate teeth on the inside of the pectoral and ventral fins in the male would help it to retain the female during copulation.

It is only the female of this species that is used for food by the poor, who prove the truth of the proverb: "the Cottus is the best of fishes, when there is no other to be got." If carefully prepared, the flesh is eatable, but it always retains a rank flavour which is repulsive to most people. The liver, however, is one of the island delicacies, but if eaten in any quantity, its flavour is also unpleasant. The male is considered poisonous by most of the islanders, and is therefore not eaten: they never bring it home, but throw it back into the sea, as soon as caught.

In the islands on the east coast this fish is sometimes taken in nets really set for the Four-horned Cottus; and in autumn it is speared with leisters by torchlight. In consequence of the indifference to danger displayed by it, the sport is by no means difficult, and is a common pastime among young people. If the fisherman misses the fish, it moves only a yard or two and stops again to await another blow. In winter it is also fished for with the *Blank-krok* (bright hook), which exactly resembles that used for Perch. The fisherman chooses a spot in deep water, at the foot of rocks or precipitous shores where the bottom is stony. Bacon, meat, the eye of the Cottus or anything eatable whatever is used as bait, for the Sea Scorpion is no dainty feeder. As it always pays more attention to the quantity than to the quality of its food, it is probably the bright hook that really entices it. In the islands on the west coast the Sea Scorpion is generally taken on the hooks cast for other, more useful fishes, and often in shore-nets or seines; but it is usually thrown away or cut up into bait for other fishes. Fabricius describes, how this fish is taken in Greenland with the *pimpeldon*.

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[a] Cf. SMITT, Catalogue of the Swedish Department of the Fisheries Exhibition in London 1883, p. 174.

(Ekström, Smitt.)

THE FATHER-LASHER (Sw. Oxsimpan).

COTTUS BUBALIS.

Plate VII, figs. 2 (♂) and 3 (♀).

Top of the head furnished with spines and ridges and rough with protuberances and bars. Four preopercular spines, the length of the uppermost in full-grown specimens being greater than the longitudinal diameter of the eye. Lateral line straight (without any sharp bend) and armed with spines. The length of the maxillary bones, which is less than the length of the ventral fins and than 80 % of the base of the anal fin, varies between 38 and 56 %, and the length of the lower jaw between 50 and 72 %, of the length of the base of the second dorsal fin. Least depth of the tail more than $5^1/_2$ *% of the length of the body and varying between 29 and 41 % of the length of the base of the anal fin. Margins of the branchiostegal membranes united to the isthmus, which separates them. Dermal fringes often present on the upper margin of the eye and always on the posterior part of the maxillary bones.*

Number of rays in the second dorsal fin at most 13, in the anal fin at most 10, in the ventral fins 4.

R. br. 6[a]; *D.* 7—8/10—13; *A.* 8—10; *P.* 14—15[b]; *V.* $^1/_3$; *C.* x+7 l. 8 l. 9+x; *L. lat.* 32—35.

Syn. *Cottus Bubalis*, Euphr., Vet.-Akad. Handl. 1786, p. 65, tab. III, fig. 2 et 3; Retz., *Fn. Suec. Lin.*, p. 328; Cuv., Val., *Hist. Nat. Poiss.*, vol. IV, p. 165, tab. 78; Nilss., *Prodr. Ichth. Scand.*, p. 97; Ekstr., Vet.-Akad. Handl., 1834, p. 72; Fr., Ekstr., Wright, *Skand. Fisk.*, ed. 1, p. 27, tab. 6, fig. 1 et 2; Kr., *Danm. Fiske*, vol. I, pp. 118 et 582; Sundev., Stockh. L. Hush. Sällsk. Handl. 1855, p. 80; Nilss., *Skand. Fn.*, *Fisk.*, p. 74; Gthr, *Brit. Mus. Cat.*, *Fish.*, vol. II, p. 164; Lindstr., Gotl. L. Hush. Sällsk. Årsber. 1866, p. 14 (sep.); Steindachn., Stzber. Akad. Wiss. Wien, LVI, I (1867), p. 694; Coll., Vid. Selsk. Forh. Christ., 1874, Tillægsh., p. 29; ibid., 1879, No. 1, p. 13; Ltkn, Vid. Meddel. Naturh. For. Kbhvn, 1876, p. 377; Malm, *Gbgs*, *Boh. Fn.*, p. 389; Winth., *Zool. Dan.*, *Fiske*, p. 9, tab. II, fig. 3; Naturh. Tidskr. Kbhvn, ser. III, vol. XII, p. 10; Day, *Fish. G:t Brit. Irel.*, vol. I, p. 51, tab. XX, fig. 2; Lillj., *Sv.*, *Norg. Fisk.*, vol. I, p. 153; Mor., *Hist. Nat. Poiss. Fr.*, vol. II, p. 302; Möb., Hcke, *Fisch. Osts.*, p. 46; Jord., Gilb., Bull. U. S. Nat. Mus., No. 16, p. 701.

Obs. Though it was our countryman, Euphrasén, who first gave the ichthyologists full information of this species, which he discovered in 1783 at Kyrksund in Bohuslän, we still find by a short, but fairly clear, description in Schonevelde (*Ichthyol.*, *Slesv. Hols.*, p. 67: "*alia Scorpii species in Sleia*") that at that early date (1624) he both knew and recognised it as distinct from the common Sea Scorpion. At about the same time as Euphrasén, Ström also discovered this species in Norway and adopted it as an independent species, two years before the publication of Euphrasén's description, under the name: *Cottus, capite lateribusque spinosis* (see Nye Samling af det Kongl. Norske Vidensk. Selskabs Skrifter, Bd. I, p. 151). Valenciennes, on the other hand, was mistaken — and in this mistake he has been followed by many — when he identified the "*Fisk-sympen*" of Tonning (Trondj. Selsk. Skrifter, 2:den Deel, Kbhvn 1763, p. 345, tab. XIII and XIV) with this species. Tonning's fish was evidently a Sea Scorpion.

The Father-Lasher belongs to a group of the genus which reaches its highest development in the Pacific Ocean. Its characters are far more sharply marked there, and there is the home of the giants of the group — the Father-Lasher is only a stunted form of the type which has otherwise been named *Enophrys*[c], *Aspicottus*[d], *Clypeocottus*[e] or *Ceratocottus*[f]. The character of this group which is perhaps most important in a systematical respect, lies in the development of the dermal fringes, which remind us of the relationship between the Cottoids and the Scorpænoids. Side by side with this, however, we find a character that reminds us of the Gurnard type, in the nakedness and roughness of the upper part of the head. The head is otherwise distinguished by the high, but deeply concave, interorbital region; the broad ridges on the top, which are poster-

[a] Sometimes 5, according to Krøyer.

[b] Or 16, according to Day, Lilljeborg and Moreau.

[c] Swainson, *Nat. Hist.*, *Classif. Fish*, vol. II, p. 271.

[d] *Aspicottus bison*, Girard, Proc. Acad. Nat. Sc., Philad. 1854, p. 130.

[e] *Clypeocottus robustus*, Ayres, Proc. Calif. Acad. Nat. Sc., 1854, p. 12.

[f] *Ceratocottus diceraus*, Gill, Proc. Acad. Nat. Sc., Philad. 1859, p. 165.

iorly continued into strong occipital spines; and the large lateral spines, the uppermost preopercular spine being especially prominent on account of its size and strength, which are sometimes almost monstrously developed, and being often furnished with lateral spines in the upper margin. Another peculiarity of this group of the genus *Cottus* lies in the armour of the lateral line, which we have indeed seen before in *Centridermichthys hamatus* and *Triglops Pingelii,* but which may here be of a strength most nearly approaching to that of the lateral plates in a *Doras* (among exotic Siluroids) or of the armour-plates in the *Agoni.* Our Father-Lasher is a dwarf in this respect too, but the Vega Expedition brought home from Behring Island[a] a *Cottus claviger,* a species of this group, which lives on sea-urchins, and of which we here give a figure in order to show at the same time how the *Cottus*-type may pass into *Cottunculus,* starting from this group as well as from the preceding, both in form and coloration, while retaining the black transverse bands on the light-gray ground colour, which otherwise characterize juvenile forms.

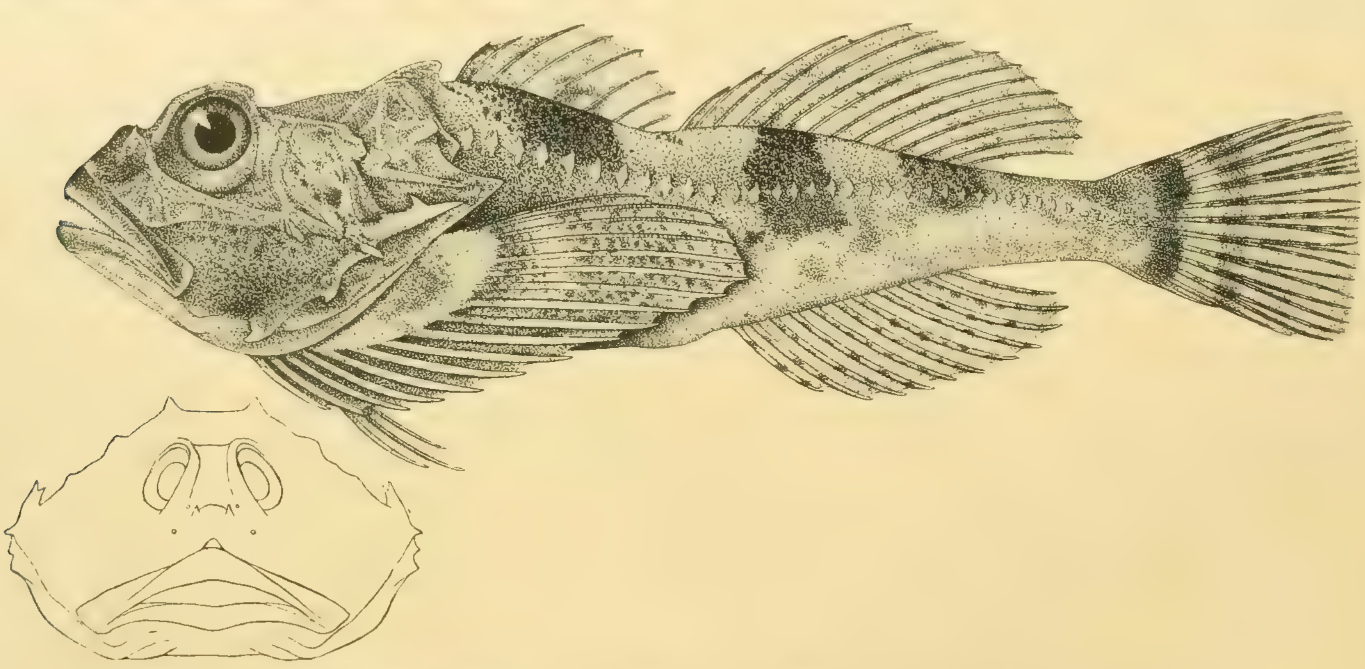

Fig. 54. *Cottus claviger,* Behring I., 15th Aug. 1879. Vega Expedition. $^2/_3$ of the natural size.

The Father-Lasher never attains so large a size as average specimens of the Four-horned Cottus or the Sea Scorpion. Among the largest specimens we have found, either in the North Sea or the Baltic, the males have been at most 150 mm. in length, the females 160 mm. The usual length of the body is between 125 and 150 mm. Generally speaking, there is a close resemblance between this species and the preceding one, both in the relative size of the parts of the body and in their forms. We, therefore, here intend to refer the reader to the description of the Sea Scorpion, and to pay attention only to the differences which may be traced between the two species. In the Father-Lasher the upper orbital margins are more elevated, and the interorbital space, therefore, deeper. These margins are also more nearly parallel, while in the Sea Scorpion they diverge posteriorly. From the raised ridges (on the parietal bones), which run from the orbital margin to the occiput and almost to a line with the beginning of the first dorsal fin, and which end, and often begin as well, in a spine directed back, there projects, at their middle point, a third, more or less distinct spine, of which there is not a trace in the preceding species. These ridges also approach each other slightly at the middle near the occiput and then slightly diverge again. From the first and middle spines there radiate several rows of fine, bony points or small tubercles, which render the sides of the ridges and the space between them rough and scabrous to the touch. There is also a similar roughness on the posterior part of the raised, upper margin of the orbit, on the higher parts of the gill-cover, on the larger spines of the gill-cover, as far as they are covered by the skin, and on the bridge which inferiorly surrounds the orbit and is posteriorly united to the preoperculum. The uppermost preopercular spine is especially remarkable for its length, as it generally not only reaches to the point of the opercular spine, but even extends beyond it. When the fish expands the gill-covers, an operation usually accompanied by a grating noise[a], and resorted to by the fish as soon as it is drawn out of the water, these long spines point upwards and outwards, in a way which gives them some resemblance to a pair of horns. From this circumstance has arisen the name of *Ox-simpa* (*bubalis*). Besides the long spine, a third part of which generally projects out of the surrounding skin, the margin of the preoperculum is furnished with three smaller spines, which vary in form, but seem to be always present: the lowest of them is turned downwards and forwards. The suboperculum is furnished with two or three pointed spines. Another character which distinguishes this species, is the circumstance that, from the margin of the skin which is united to the upper part of the eye, and which resembles an eyelid, there hang down over the margin of the iris five or six small, thin, dermal filaments, the next to the last being twice as long as the others and, during life, erected vertically upwards[b]. A similar, though much longer, dermal filament — or sometimes two — appears at the truncate end of the upper jaw-bone[b]. The branchiostegal membrane is inferiorly united to the isthmus, without a free fold across the latter. The course of the lateral line is fairly straight and forms no curve in its posterior part. It is generally armed with stiff points, which are anteriorly set in large numbers on the small, slightly raised, scaly disks which form the line, but gradually diminish in number posteriorly and, as a rule, completely disappear at the end of the second dorsal fin[c]. The scattered, pointed, scaly plates with which the sides of the Sea Scorpion are furnished, are entirely wanting in this species in its adult state; but it passes through a larval stage, so to speak, during which it has pointed, scaly spines on the anterior part of the body, both above and below the lateral line. These spines have disappeared, however, when the fish has attained a length of 26 mm.[d], and the somewhat granulated skin is subsequently quite unarmed and covered with a clear, thick mucus. The two dorsal fins are quite distinct, but often only imperfectly separated from each other. The membrane of the anterior fin is often united to the base of the first ray in the second, higher up in some specimens than in others. In the first dorsal fin there are generally 8 rays, but sometimes only 7, the two first being usually closely joined at the base; in the second from 10 to 12 and sometimes 13. The anal fin contains 8 or 9 rays and sometimes 10. The pectoral fins, in which there are 14 or 15 rays, are completely without the serrate ridges which appear on the inside of the rays in the Sea Scorpion. This is also the case with the ventral fins, which have one, short, spinous ray, hidden by the skin, and three simple, articulated rays, the middle one being the longest. The caudal fin contains from 12 to 14 rays, from 7 to 9 of the middle ones being branched at the tip.

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[a] Cf. Smitt, Catalogue of the Swedish Department of the Fisheries Exhibition in London 1883, p. 175.

In external form the difference between the sexes is less striking in this species than in the preceding one. The *male* may be recognised, however, by the more slender body, the larger spines on the head and the elevation of the anal region into a long, conical papilla. As usual, however, its chief external distinction lies in the greater length of the fins, especially of the ventral, which in this sex, at least when the fish is over 60 mm. in length, apparently vary between 16 and 20 % of the length of the body, and in ordinary cases extend as far back as the vent or even farther. The base of the anal fin, too, is generally longer in the male, but the distance between the insertion of the ventral fins and the beginning of the anal fin is less in the male than in the female, a circumstance which gives us the general rule that, in the male the base of the anal fin is at least 80 % of this distance, in the female at most 76 %. Further, in those respects in which distinct changes of growth appear, the male represents, in this species also, the lowest stages of development, e. g. in the size of the eyes (see the table below).

The difference between the sexes is more apparent if we observe the coloration, though it is extremely variable. Our plate gives the colouring of both sexes as it usually appears (the originals are from the Baltic). The prevalent green colour is a distinguishing mark of this species; it even extends into the mouth, and the iris has green radii from the pupil. From the ordinary dress of the Father-Lasher one can scarcely form an idea of its attire during the spawning-season. Nature then lavishes upon it a wealth of colour which one cannot sufficiently admire, and which it would be difficult, if not impossible, to reproduce with the painter's brush. We shall endeavour to describe the male in its spawning dress. The head, back and tail olive-green, darker above, with a dash of yellowish brown, lighter below, shading into green. The top of the head marbled with dark olive-brown and thinly strewn with bluish green spots; the lower part of the head adorned with numerous, golden figures, interspersed with a few whitish blue or pearl-coloured spots. The top part of the body crossed by four, dark olive-brown, transverse stripes, the first of which is the broadest and extends down to the insertion of the pectoral fin; the others strictly extend only to the lateral line, but may be regarded as being continued a little way below it by several, large, scattered figures. All these transverse stripes are coasted by a narrow, pearl-coloured margin, which is wanting only along the anterior edge of the first stripe. The belly half-way up the sides, and the breast a handsome golden yellow, with three round, pearl-coloured spots: one in front of the vent, one by the ventral fins and the third on the breast; there is also a whitish stripe straight across the hyoid bone. Along the lower side of the lateral line scattered, small spots of a bluish green tint — a larger spot of the same colour at the end of the line. The pectoral fins yellowish brown, the lowest 7 rays olive-green, with distinct, dark-brown, transverse stripes, which gradually fade away on the membrane, which is lighter and speckled with brown: on the inside of these rays three or four light, pearl-coloured, round spots between the transverse stripes. Three larger spots of the same colour, edged with a narrow, blackish brown margin, in a row just in the axil. The ventral fins olive-green at the base, then light blue, with brownish spots both on the rays and on the membrane. The anal fin yellowish brown, with somewhat darker rays, on which there are three or four dark russet, transverse stripes. The caudal fin, like the second dorsal, yellowish brown with darker rays, four or five dark russet stripes and a flame-coloured, darker yellow membrane. The first dorsal fin darker than the second, more grayish brown, with a large blackish brown spot between the fifth and seventh rays, and throughout finely marbled with the same colour, though of a lighter shade. The iris blackish brown, with a fine, yellow ring round the pupil, and bluish green radii.

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[a] According to SORENSEN (*Om Lydorganer hos Fiske.* Kbhvn 1884, p. 79) this sound originates at the articulation of the preoperculum with the hyomandibular bone. According to DUFOSSÉ (Ann. Sc. nat., ser. 5, Tome XIX et XX — 1874), we may conclude that the vibration in the articulation, which is the immediate cause of the sound, is due to the vibration of the muscles of the hyomandibular apparatus which in these muscles, as in all others, accompanies their strongest possible contraction. This sound also occurs, though there it is weaker, in the preceding species.

[b] Cf. above, on *Centridermichthys hamatus.*

[c] In a specimen 71 mm. in length from Waideguba (Kola Peninsula) the lateral line is without any spine whatever, except the stiff margin of the middle pores, which is raised in a posterior direction.

[d] Cf. MALM and COLLETT.

In the structure of the internal organs there is no difference worthy of remark between this species and the Sea Scorpion.

The Father-Lasher is known, as appears from the collections of the Royal Museum, from Waidegula (on Kola Peninsula, near Norway) round all the coasts of Scandinavia, up the Baltic as far as the island-belt of Stockholm. Southwards, along the European side of the Atlantic, its geographical range extends, according to MOREAU, to the middle of the west coast of France, and according to STEINDACHNER, to the coast of Galicia. We have no knowledge of its occurrence in Greenland (cf. JORDAN and GILBERT). It lives only in salt water. On the coast of Scandinavia, up to the year 1833, it had been met with only in Bohuslän and Norway; but it was then found by Count BONDE in the Baltic, among the islands round Mörkö. In the latter place, and also in the island-belt of Stockholm (cf. SUNDEVALL), it has often been found since that time, but it occurs in no great number and is taken only occasionally. When it is caught, one generally gets a pair, male and female. In the island-belt of Bohuslän, on the other hand, it is by no means rare, and is taken there almost as often as the Sea Scorpion, during the shooting of the seine: specimens of all ages are found, both in summer and in winter. In the Sound, according to WINTHER, it is most numerous and largest at the deeper spots, where the water is from 6 to 10 fathoms in depth, and the bottom is overgrown with seaweed and not of too loose a nature. The fishermen scarcely take the trouble to notice this fish at all: they generally throw it away or, at most, use it as bait. They have generally no special name for it, but use the same name, *Ulk*, both for it and for the Sea Scorpion. MALM states, however, that on Kyrkösund it is called *Hornulke* and on Sydkoster *Bergulke*. According to NILSSON it is called *Dvergulk* at Abekås.

The spawning-season of the Father-Lasher, at which time it is taken in the greatest numbers, occurs at the end of November and in December. Its food is the same as that of the other Scandinavian *Cotti*, consisting chiefly of crustaceans and small fishes. With these exceptions we know very little of its manner of life. No special method of fishing is practised for this species, nor is it used as food. (EKSTRÖM, SMITT.)

COTTUS LILLJEBORGII.

(Fig. 55.)

Top of the head furnished with spines and ridges, and rough with protuberances. Four preopercular spines, the length of the uppermost being scarcely greater than the longitudinal diameter of the eye, but extending usually as far back as the point of the opercular spine. Lateral line straight and, like the sides of the body, especially above the lateral line, armed with spines. The length of the maxillary bones, which is greater than that of the ventral fins and more than 80 % of that of the base of the anal fin, varies between about 55 and 65 %, and the length of the lower jaw between about 65 and 75 %, of the length of the base of the second dorsal fin. Least depth of the tail more than $5^1/_2$ % of the length of the body, and varying between about 35 and 45 % of the base of the anal fin. Margins of the branchiostegal membranes united to, and separated by, the isthmus[a]. *Dermal papillæ on the upper margin of the eye, and dermal filaments on the hind part of the maxillary bones. Rays in the second dorsal fin at most 12, in the anal fin 8 or 9, in the ventral fins 3.*

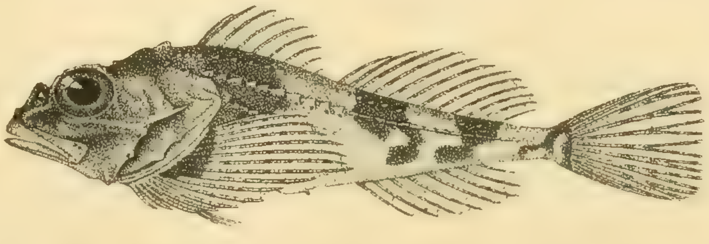

Fig. 55. *Cottus Lilljeborgii*, ♀, from Bohuslän. Magn. 2 diam.

R. br. 5 l. 6; *D.* 8|11 l. 12; *A.* 8 l. 9; *P.* 15 l. 16; *V.* $^1/_2$; *C.* $x+7+x$; *L. lat.* 25 ad 30 l. 31.

Syn. *Cottus Lilljeborgii*, Coll., Vid. Selsk. Forh. Christ., 1874, Tillægsh. p. 25; Ltkn, Vid. Meddel. Naturh. For. Kbhvn, 1876, p. 376; Coll., l. c., 1879, No. 1, p. 13; Lillj., *Sv., Norg. Fisk.*, vol. I, p. 158; Malm, Gbgs Naturh. Mus. Årsskr. 1881, p. 21; Coll., N. Mag. Naturv. Christ., Bd.29, H. 1, p. 54.

If the Father-Lasher, in relation to the Sea Scorpion, can be called the Dwarf Cottus (*dvergsimpa*), this name may be applied with still greater propriety to Lilljeborg's Cottus, the length of which, according to Lütken, is known to rise as high as 54 mm. in the Faroe Islands, but in Scandinavia has never exceeded 47 mm. In relation to the preceding species, however, it occupies, in most respects, a place corresponding to the highest degree of development of the former, though it retains the above-mentioned spines on the sides of the body, especially above the lateral line, which in the Father-Lasher are a character of the larval stage. The other character which most distinguishes Lilljeborg's Cottus, consists in a shortening of the occipital ridges (the posterior part of the ridges on the top of the head), which thus end in their posterior, spinous point at a greater distance from the beginning of the first dorsal fin. Though the separation between the two dorsal fins is more distinct than is generally the case in the preceding species, still we can apparently find no constant difference in this respect. On the other hand, the great difference in the length of the maxillary bones[b], especially in comparison with the length of the ventral fins, should afford a definite character easy of employment. The spinous armour of the body displays a striking similarity to that of *Centridermichthys hamatus*, but is still closer, especially above the lateral line, and extends as far back as the end of the second dorsal fin. One row of these spines, more developed than the others, coasts the bases of both dorsal fins, just as in the species referred to. Below the lateral line too, there are numerous spinous scales on the anterior part of the sides, but on the posterior part they are thinly scattered. The belly is smooth or finely granulated. These spinous scales[c] are simple spines, erected in a backward direction, just like those of the lateral line[d].

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[a] Sometimes, however, with a distinct trace of a dermal fold straight across the isthmus.

[b] Even Collett remarked that in *Cottus Lilljeborgii* the gape is relatively larger and broader than in *C. bubalis*.

[c] "Granular points", Malm; "bony protuberances", Lilljeborg.

[d] Cf. the above description (p. 189, note *c*) of the armour of the lateral line in a specimen of *Cottus bubalis* from Waideguba.

The coloration of LILLJEBORG'S Cottus is essentially the same as that of young *Cotti* in general and especially like that of young Father-Lashers. It is pale yellow, with four or five broad, black, transverse bands over the head and back, the last two or three extending over the caudal region down to the ventral side and more or less confluent. The fins are crossed by rows of grayish brown spots.

Lilljeborg's Cottus is known from the shallower spots on the coast of Norway up to Trondhjem Fjord, from Bohuslän and from the Faroe Islands. According to MALM'S observations in Bohuslän, it "generally lives at about the same depth as *Cottus scorpius;* but as the latter is most often found in the Zostera region and *C. bubalis* in the Laminaria region, it would appear that *C. Lilljeborgii* prefers the Corallina region." Of the specimens belonging to the Royal Museum two were taken by Lecturer OLSSON on the coast of "Bohuslän, 1869," together with *Cottus bubalis,* and another by Professor S. LOVÉN in Gullmaren. MALM mentions eight specimens from Bohuslän, belonging to Gothenburg Museum; but whether the species is common there, we can hardly judge as yet.

Cottus Lilljeborgii is of no economic importance, but is all the more interesting from a scientific point of view, for most of the characters assigned to it above, correspond to the highest stages of development in the preceding species, but are combined with a retention of the spinous, larval dress of the latter. So closely related to each other are these two species, that one might reasonably regard Lilljeborg's Cottus as a Father-Lasher which had adopted in youth the characters of the adult state. This opinion, however, is refuted by the difference which lies in the above-mentioned shortening of the occipital ridges and in the smaller number of rays in the ventral fins, the former circumstance indicating a special approach towards *Cottus claviger.* As long as a constant difference exists, we must, of course, retain the species in the system as distinct. In other respects we see, according to the table given below, that, where in *Cottus Lilljeborgii* the proportion is highest — e. g. in the length of the maxillary bones relatively to the length of the body — *Cottus bubalis* approaches it by the increase of the proportion with age. Again, where in the former species the proportion is comparatively low — e. g. in the relative lengths of the base of the second dorsal fin and of the body — we find in *Cottus bubalis,* both in the male and in the female, that the proportion sinks with age, more or less regularly, but still distinctly. The table also shows the relations between these two species and their near relative *Cottus claviger.*

	Cottus bubalis.									*Cottus Lilljeborgii.*		*Cottus claviger.*
	Bohuslän. S. LOVÉN, 1871.	Bohuslän, Hunnlesäcken, 16th April, 1887. H. STRÖMFELT.	Bohuslän, Kristineberg 1885.	Bohuslän 1869. OLSSON.	Bohuslän, Kristineberg 1885.	Kola Peninsula. Waideguba, 28th September, 1877. H. SANDEBERG.	The Baltic. Mörkö, Nov. 1883. EKSTRÖM.	The Sound. Råå 1882. TRYBOM.	Bohuslän, July, 1835. F. SUNDEVALL.	Bohuslän 1869. OLSSON.	Bohuslän. S. LOVÉN.	Behring I. 15th Aug., 1879.
		♂	♂	♂	♂	♀	♀	♀	♀	♂	*	♂
ength of the body expressed in millimetres	26.2	63	66	70	125	71	133	139	160	41	47	257
„ „ „ head in % of the length of the body	30.9	30.1	31.8	33.7	33.6	29.6	33.8	32.4	33.9	31.6	31.5	34.2
„ „ „ maxillary bones „	10.7	11.1	11.8	10.0	12.4	10.6	12.4	12.6	13.8	14.6	14.0	13.6
„ „ „ lower jaw „	13.7	14.6	16.0	16.1	16.8	14.1	15.0	15.8	16.9	17.5	16.6	16.8
ongitudinal diameter of the eye „	9.6	7.9	7.9	7.4	7.0	5.7	6.2	6.1	6.2	8.8	8.9	5.6
istance between the first dorsal fin and the tip of the snout „	30.6	29.0	31.8	30.0	31.6	28.6	31.7	30.2	31.2	29.5	28.7	32.3
„ „ „ beginning of the first dorsal fin and that of the second „	19.1	17.4	19.7	20.0	19.8	18.7	20.3	20.1	16.6	17.1	21.3	17.5
ase of the second dorsal fin „	25.9	28.6	27.3	24.7	24.0	28.2	24.0	23.8	25.0	23.4	25.5	24.9
ength of the ventral fins „	11.4	16.0	16.7	17.1	20.0	15.5	15.0	13.0	14.3	12.2	12.7	15.1
istance between the insertion of the ventral fins and the beginning of the anal fin „	21.3	21.9	22.7	24.3	23.2	31.4	26.3	25.2	23.1	25.6	25.7	33.0
istance between the tip of the snout and the beginning of the anal fin „	45.8	47.6	45.8	48.6	51.6	48.7	52.6	50.3	50.6	51.7	51.1	53.4
ase of the anal fin „	19.1	20.5	18.2	20.0	19.2	18.3	15.9	18.0	17.5	14.6	16.6	17.5
east depth of the tail „	6.8	6.0	6.0	6.1	6.0	6.3	6.6	6.0	5.8	6.6	5.9	6.6
east breadth of the interorbital space in % of the length of the maxillaries	46.4	42.9	41.0	50.0	35.5	34.7	33.3	30.0	34.1	33.3	27.3	31.4
ength of the maxillaries in % of the base of the second dorsal fin	41.2	38.8	42.8	40.4	51.7	37.5	51.5	42.7	55.0	62.5	55.0	54.7
„ „ „ lower jaw	53.0	51.1	57.7	65.3	70.0	50.0	62.5	53.6	67.5	75.0	65.0	67.6
east depth of the tail in % of the longitudinal diameter of the eye	72.0	76.0	76.9	82.6	84.1	112.5	107.3	98.8	93.0	75.0	66.7	117.2

SUBFAMILY TRIGLINÆ.

Head cuirassed. Air-bladder present.

The presence of the air-bladder and the appearance of the head, which is almost naked, but armed by the thickening and granulation of the external bones, together with the fairly uniform covering of scales on the body, distinguish the subfamily of the Gurnards from that of the true Cottoids. In the preceding subfamily, however, we have seen numbers of intermediate forms between it and the Gurnards. In a specimen of *Cottus claviger* a great part of the head displays the same nakedness and the same granulation; but the most striking external similarity appears in the spines which occur along the base of the dorsal fins in *Centridermichthys hamatus*, *Cottus Lilljeborgii* and the young specimens of *C. bubalis*. Similar spines are here a constant character of that genus which has given its name to the subfamily, and here they are firmly attached to the subjacent interspinal bones, a circumstance which, as a rule, renders their number constant in each species and equal to the total number of rays in the two dorsal fins. The difference between the upper and lower rays of the pectoral fins, which is well marked in the preceding subfamily, is here maintained in one of two ways: either some of the lower rays become free, digitate organs of touch and motion, or the upper (smaller) part of these fins (in *Dactylopterus*) is wholly detached from the lower (posterior). In connexion with the cuirass of the head we find a marked development of the bones of the suborbital ring, which are firmly united posteriorly to the preoperculum and anteriorly cover the sides of the whole snout, projecting to a greater or less extent — in some forms like spatulate processes — beyond the snout itself, and at the same time covering the maxillary bones, when the mouth is closed. The development of the air-bladder constitutes a distinct difference from the preceding family: the sounds which the Gurnards are capable of producing much more generally and more loudly — a circumstance which has given them their Swedish name, *knorrhanar* ("Crooners") — arise from or at least are intensified by the vibrations of the air-bladder. These vibrations are due to the strong contraction, accompanied also by rapid vibrations[a], of the muscular sheathing of the air-bladder itself, of the adjacent intracostal muscles or even of the large lateral and abdominal muscles. For the same purpose the air-bladder is furnished with special muscles, and also, probably for the same purpose, the property of changing the strength and tone of the sounds, generally divided into chambers by a constriction, either anteriorly, as in *Trigla gurnardus*, or anteriorly and posteriorly, as in *Dactylopterus:* it may also have lateral processes, as in *Trigla lucerna*, in the form of long horns, lying along the sides[b]. The gill-openings are generally normal in these fishes; and there is a perfect branchial slit even behind the fourth branchial arch. Through the strong covering of scales on the body several of these fishes, notably *Dactylopterus* and *Peristedion*, come so near the following family (*Agonidæ*) that they have sometimes[c] been referred to it; but the structure of the head and the air-bladder speaks in favour of their retention close to the Gurnards.

The appearance of the Gurnards is peculiar, but their manner of life still more so. The Gurnards and Malarmats are really to be regarded as bottom-fishes which use the free, lower rays of the pectoral fins as feelers in searching for food at the bottom, or even as creeping-organs, and which often betray, by the traces of wear in the points of the prominent preorbital bones, that these bones have been used to root up the bottom. But they are frequently found in the open sea, and are then scarcely inferior in swiftness of motion to any other fish, not excepting the Mackerel. Their relatives, the Flying Gurnards, always sport at the surface, or leap up into the air, hovering there on their parachutes, the large pectoral fins, which are spread like wings.

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[a] According to DUFOSSÉ. LINNÆUS, in his concise, but telling, style, described this sound with perfect fidelity to nature, and hinted at its source in *Trigla gurnardus*: "Captus in abdomine murmurat, moribundus tremit" (*Fauna Suecica*, ed. II, p. 120). (Cf. also MOREAU, Comptes Rendus, 1864, II, p. 436.

[b] Cf. YARRELL, *British Fishes*, ed. 2, vol. 1, p. 40; KRØYER, *Danmarks Fiske*, vol. 1, p. 116; DUFOSSÉ, Ann. d. Sc. Nat. sér. 5, Tome XIX (1874), art. No. 5, pp. 38 etc., pl. 16—19; Tome XX (1874), art. No. 3, pp. 47 etc.; SØRENSEN, *Om Lydorganer hos Fiske*, p. 129.

[c] GÜNTHER, *Introd. Stud. Fish.*, p. 481 (*Handb. Ichthyol.*, p. 341).

The subfamily is represented in all the tropic and temperate seas. JORDAN and GILBERT estimate the number of species at about 40, distributed among 5 genera. Only one of these genera belongs to the Scandinavian fauna.

GENUS TRIGLA.

Ventral fins far apart and containing 5 soft rays. The three lower rays of the pectoral fins free and finger-like. The lower jaw, the intermaxillary bones and the head of the vomer set with fine, cardiform teeth: the palatine bones toothless. The true scales thin, ciliate and extremely small.

In olden times, and even in ARTEDI, the Gurnards were referred to the same genus as the Mullets; and the generic name *Trigla* ought really to be conferred on the latter fishes, if more attention were paid to classical order than to LINNÆUS's authority[a]. We now, indeed, set them far apart in the system; but the opinion of the old writers finds some ground not only in the red colouring, which often prevails in the Gurnards too, but also in the structure of so important an organic system as that of the lateral line. In the Gurnards this system is insignificant on the cuirassed head; but its distribution on the body reminds us of that in *Mullus*, and is sometimes far better developed. The scales of the lateral line are much larger than those of the rest of the body, and often armed with spines, as in some *Cotti*. They are sometimes of the usual form, oblong or of slightly greater depth than length, and pierced with only few branches of the lateral canal — as in *Trigla gurnardus*, where only one lateral branch of this canal runs obliquely downwards and backwards in the posterior part of the scale. Sometimes, however, they are pierced with a finger-like branching of the canal, which strongly resembles that in *Mullus*[b], as in the middle of each scale of the lateral line in *Trigla pini*. In this species, however, these scales are diminished in length, but increased in depth, by lateral processes (upwards and downwards) which call to mind the scales in *Pterycombus*: in each of these scales, too, the canal sends out two lateral branches, one upwards and one downwards, each with lateral ducts in a backward direction, which, like the chief branch, open into pores in the scale. In some instances the scales of the lateral line are prolonged upwards to the spinous plates of the dorsal fin-groove, or the two lateral branches are so well developed that they are continued, with lateral ducts and pores, in dermal folds both above and below the scales of the lateral line. In *Trigla lineata*, an inhabitant of the Mediterranean and the neighbouring parts of the Atlantic, the system may spread in this way almost over the whole of the body. Furthermore, the lateral line in the Gurnards is not only unbroken and perfect along the whole body, but also divides, at the tail, into two, forked branches on the caudal fin: the upper branch usually runs between the second and third rays above the middle of the fin, the lower between the first and second rays below this point; and, as a rule, both these branches extend to the extreme hind margin of the fin. With regard to the structure of the fin rays in this genus, we may remark that, as a rule, by far the greater portion of the rays in the anal fin are simple, only the antepenultimate and penultimate being sometimes branched at the tip, while in the second dorsal fin most of the rays are branched, only the first two or three being simple. All the latter rays are, however, articulated, and the last two are very closely joined at the base.

The genus *Trigla* contains about 15 known species, and is spread over the Atlantic, though not known with any certainty in its western regions, round the Cape of Good Hope to New Zealand. The three species found within the limits of the Scandinavian fauna may be distinguished as follows:

A: Scales of the lateral line high, their upper processes extending to the lateral plates of the dorsal fin-groove	*Trigla pini.*
B: Scales of the lateral line of ordinary form.	
a: Scales of the lateral line spinous. Pectoral fins shorter than the base of either the second dorsal or the anal fin	*Trigla gurnardus.*
b: Scales of the lateral line unarmed. Pectoral fins longer than the base of either the second dorsal or the anal fin	*Trigla lucerna.*

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[a] *Systema Naturæ*, ed. X, tom. I, p. 300.

[b] See EKSTRÖM, *Om Fjällens byggnad hos Osteopterygii*, disp. Lund 1874, tab. I, fig. 13.

THE RED GURNARD (SW. RÖDKNOTEN[a])

TRIGLA PINI.

Fig. 56.

Scales of the lateral line 70—73 in number, unarmed, thin, elongated upwards and downwards by processes, the upper ones extending to the spinous plates of the dorsal fin-groove, of which the posterior are smooth, but sharp, and end in a spinous point, the anterior (at the sides of the first dorsal fin) serrated. Number of these spinous plates 27 or 28. First spinous ray of the anterior dorsal fin tuberculated or serrated at the anterior margin. Length of the head $^1/_4$ of that of the body. Length of the snout less than $^1/_2$ of that of the head. Interorbital space concave: its breadth in young specimens $^1/_9$, in old $^1/_7$, of the length of the head. Diameter of the eye in old specimens nearly $^1/_4$[b] *of the length of the head. Pectoral fins somewhat shorter than the head*[c], *whitish on the outside and dark blue or greenish gray on the inside. Colour of the body rose-red.*

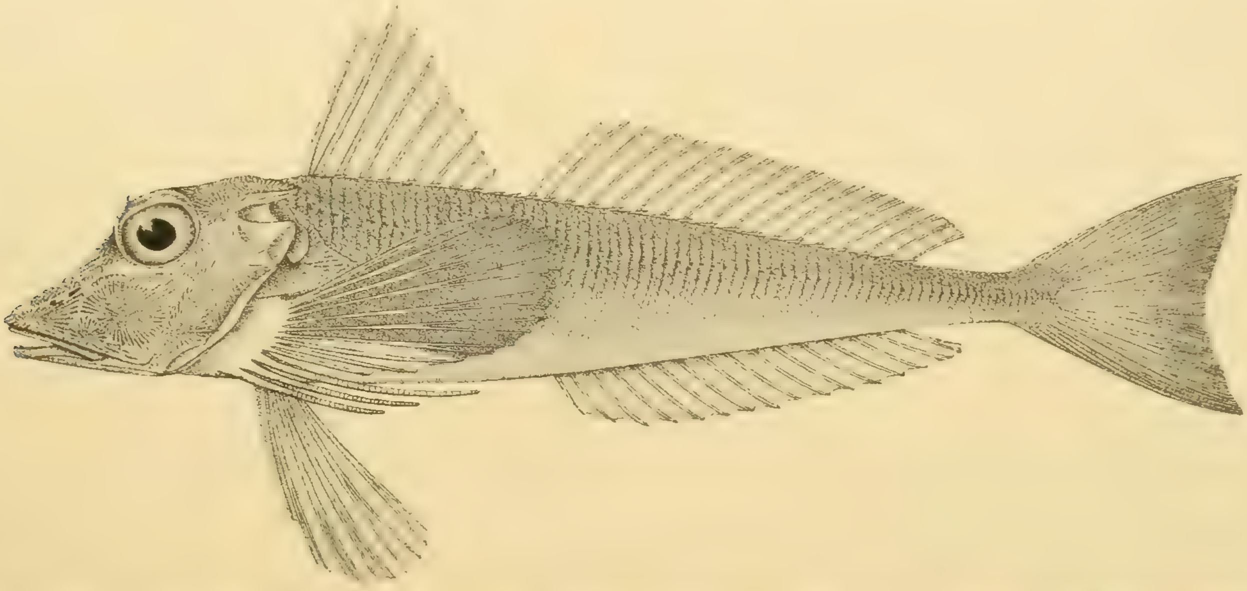

Fig. 56. Red Gurnard (*Trigla pini*). $^8/_{15}$ of the natural size. From Strömstad, 3rd June, 1869. Specimen belonging to Gothenburg Museum.

R. br. 7: *D.* 8. l. 9|18 l. 19: *A.* 16 l. 17: *P.* (1+7+3)+3: *V.* $^1/_5$: *C.* $x+9\binom{5}{4}+x$: *L. lat.* 70-73.

Syn. *Cuculus*, WILLUGHBY (*ed.* RAII) p. 281 (descr., nec fig.); ART. (*Trigla*, 7) *Gen.*, p. 45; *Syn.*, p. 74; LIN. (*Trigla cuculus*) *Syst. Nat.*, ed. X, tom. I, p. 301 (synon. vix hujus spec. quia *D.* 9|16 l. 17 dicitur; vide *adn.* infra).

Trigla pini, BLOCH, *Ausl. Fisch.*, part. VII, p. 130, tab. CCCLV; GTHR, Cat. Brit. Mus., Fish., vol. II, p. 199; MOREAU, *Hist. Nat. Poiss. Fr.*, part. II, p. 266.

Trigla cuculus, YARR., *Brit. Fish.*, ed. 2, part. I, p. 38; STEIND., Stzber. Akad. Wiss. Wien., LVI, I (1867), p. 680; MALM, Öfvers. Vet. Akad. Förh. 1870, p. 825; COLL., Vid. Selsk. Forh. Christ., 1874, Tillægsh., p. 37; MALM, *Gbgs. Boh. Fn.*, p. 397; TILLIER, Mém. Soc. Sc. Nat., Math. Cherbourg, tom. XXII (1879), p. 276; DAY, *Fish. G:t Brit., Irel.*, part. I, p. 58, tab. XXIII; LILLJ., *Sv., Norg. Fisk.*, part. I, p. 179; JORD., GILB., Bull. U. S. Nat. Mus., No. 16, p. 733.

Obs. Before BLOCH's time this species cannot be regarded as fixed with any certainty. LINNÆUS in his *Systema Naturæ*, ed. X, was chiefly only ARTEDI's mouthpiece; and the latter has evidently copied WILLUGHBY, whose figure (in Plate S. 2) represents a *Trigla lyra*. The number of rays in the second dorsal fin which LINNÆUS (l. c.) assigns to this species, also shows that he really referred to the latter species; and this is also the case with *Trigla cuculus* in his *Museum Adolphi Friderici, tom. 2di, prodr.*, p. 93. Among other relics of this Museum the present Royal Museum still possesses five jars: one labelled *Trigla cataphracta* and containing a specimen of *Peristedion cataphractum*; two labelled *Trigla cuculus*, the one containing a specimen of *Trigla lyra* and the other one specimen of the same species and another of *Trigla lucerna*, var. *poeciloptera*; a fourth labelled *Trigla hirundo* and containing a *Trigla gurnardus*; and a fifth labelled *Trigla hirundo*, β and containing a *Lepidotrigla aspera*.

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[a] MALM, l. c.

[b] In young specimens as much as $^3/_{10}$, according to STEINDACHNER.

[c] $^4/_{17}$—$^4/_{19}$ of the length of the body, according to TILLIER.

The Red Gurnard is, in all probability, scarcely to be considered as a stationary fish within the limits of the Scandinavian fauna. It is common on the coasts of Great Britain and Ireland and the west coast of France[a]; but in Spain and Portugal STEINDACHNER found only solitary specimens in the fish-markets, and in the Mediterranean, according to BONAPARTE[b], it is less common than in the Atlantic, where it also becomes probably rarer the farther south we go, for in Madeira, according to LOWE[c], it is "rarior". It is the only true *Trigla* which has sometimes, it is stated, been found on the American coast[d], where this genus is else represented by *Prionotus*, with teeth on the palatine bones as well. According to VALENCIENNES it is highly valued in Paris for the firmness and good flavour of its flesh, and often brought to market. In Scotland, according to COUCH[e], it is held in small esteem; but in England it is said to sell well, and only on account of its inferior size to be regarded as inferior to the Tub-fish and the Piper. "The usual habit," says COUCH, "of this species, as of the whole family, is to keep near the bottom in moderately deep water; and there they feed on shellfish, crabs and small fishes, with a variety of other creatures inhabiting the bottom of the sea. They also take a bait freely, but are caught in the greatest abundance with trawls. I have found them with spawn well developed at the opposite seasons of January, April and June."

In Scandinavia, to the best of our knowledge, only two specimens have been taken, and these at about the same date in places not far apart. The one was taken "about 1869" according to COLLETT, in Christiania Fjord, the other was caught on the 3rd of June, 1869, just off Strömstad, and preserved by Dr. C. CEDERSTRÖM. The latter specimen now belongs to Gothenburg Museum, and was lent us by the Keeper, Dr. A. STUXBERG, to serve as the original of our figure. As it has been described minutely by Professor MALM, we shall here content ourselves with adding some of its most characteristic points; and for the sake of comparison, we append the corresponding measurements made on specimens of the two following species.

	Trigla pini.	*Trigla gurnardus.*	*Trigla lucerna* var. *poeciloptera.*
Length of the body from the middle of the tip of the snout to the middle of the hind margin of the caudal fin, expressed in millimetres	295	298	224
Length of the head to the tip of the opercular flap ... in % of the length of the body	26.1	26.8	26.8
„ „ „ „ „ „ top of the hind margin of the preoperculum ... „ „ „ „ „ „ „ „	21.0	21.5	21.6
„ „ „ snout „ „ anterior margin of the orbit ... „ „ „ „ „ „ „ „	12.5	11.7	12.1
„ „ „ „ „ „ anterior nostril ... „ „ „ „ „ „ „ „	4.4	4.7	4.9
Length of the body from the middle of the tip of the snout to the point of the pectoral fins, when folded ... „ „ „ „ „ „ „ „	45.8	42.9	55.4
Length of the pectoral fins ... „ „ „ „ „ „ „ „	23.4	18.4	30.3
„ „ „ ventral „ ... „ „ „ „ „ „ „ „	22.4	21.0	23.6
Distance from the middle of the tip of the snout to the vent ... „ „ „ „ „ „ „ „	44.7	48.6	46.0
Length of the base of the first dorsal fin ... „ „ „ „ „ „ „ „	16.5	15.4	14.3
„ „ „ „ „ „ second „ ... „ „ „ „ „ „ „ „	32.2	30.2	29.2
„ „ „ „ „ „ anal „ ... „ „ „ „ „ „ „ „	29.6	29.5	25.5
Length of the second ray in the first dorsal fin ... „ „ „ „ „ „ „ „	16.0	17.1	14.5
Greatest depth of the body at the beginning of the first dorsal fin ... „ „ „ „ „ „ „ „	16.6	19.4	14.5
„ breadth „ „ „ „ „ „ „ „ „ „ „ „ ... „ „ „ „ „ „ „ „	14.2	14.3	14.0
Least depth of the tail ... „ „ „ „ „ „ „ „	4.1	3.7	4.4
Least breadth of the interorbital space ... „ „ „ „ „ „ „ „	3.4	5.7	4.5
Longitudinal diameter of the eye ... „ „ „ „ „ „ „ „	6.4	6.0	5.8

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[a] CUV., VAL., *Hist. Nat. Poiss.*, vol. IV, p. 33.

[b] *Icon. Fauna Italica*, *Pesci*, No. 96 (Fasc. XI, p. 58).

[c] Trans. Zool. Soc. London, vol. II (1841), p. 175.

[d] VALENCIENNES, l. c., p. 54: MITCHILL, Trans. Lit. Phil. Soc. N. York, vol. I, p. 449 (*Polynemus tridigitatus*, according to DAY, l. c.); JORD., GILB., l. c.

[e] *Fish. Brit. Isl.*, vol. II, p. 19.

THE GREY GURNARD (SW. KNORRHANEN.)

TRIGLA GURNARDUS.

Plate XI, fig. 1.

Scales of the lateral line about 73 in number[a]*, scutiform, reversely linguiform or obovate, armed with spines. Marginal plates of the dorsal fin-groove 27 or 28 in number, tuberculated*[b]*, but extremely seldom spinous. First two or three*[c] *spinous rays of the anterior dorsal fin tuberculated. Length of the head to the tip of the opercular flap (relatively greater in old specimens than in young) from 25 to 27 % of the length of the body. Length of the snout less than* $^1/_2$ *that of the head. Breadth of the interorbital space, which is slightly concave*[d]*, about* $^1/_5$ *or* $^1/_4$*, and the diameter of the eye about 22 %*[f]*, of the length of the head. Pectoral fins (usually longer in the male than in the female) considerably shorter than the head*[g]*, blackish or gray, with white rays — the 7 or 6 middle ones branched once — and with white spots on the inside. Colouring of the body superiorly gray or brownish red, with or without white spots and longitudinal white stripes on the sides.*

R. br. 7: *D.* 8 l. 9 18—20; *A.* 18—20; *P.* (1 + 7 + 3 l. 1 + 6 + 4) + 3; *V.* $^1/_5$; *C.* $x + 9 + x$: *L. lat.* 72—76.

Syn. *Gornatus* seu *Gurnardus griseus*, WILLUGHBY (ed. RAII) p. 279. *Trigla*, No. 8: ART., *Gen. Pisc.*, p. 46; *Syn. Pisc.*, p. 74.

Trigla Gurnardus, LIN., *Syst. Nat.*, ed. X, tom. I, p. 301; BLOCH, *Fische Deutschl.*, part. II, p. 121, tab. LVIII; RETZ., *Fn. Suec.*, LIN., p. 341; FABER, *Fische Isl.*, p. 123; CUV., VAL., *Hist. Nat. Poiss.*, vol. IV, p. 62; NILSS., *Prodr. Ichth. Scand.*, p. 87; FRIES, EKSTR., WR., *Skand. Fisk.*, ed. 1, p. 15, tab. 3, fig. 2; KRØY., *Danm. Fiske*, vol. I, pp. 83 et 581; YARR., *Brit. Fish.*, ed. 2, part. I, p. 53; NILSS., *Skand. Fn.*, *Fisk.*, p. 53; GTHR, Cat. Brit. Mus., Fish., vol. II, p. 205; COUCH, *Fish. Brit. Isl.*, vol. II, p. 27, tab. LXVIII; MALM, Öfvers. Vet. Akad. Förh. 1870, p. 829; COLL., Vid. Selsk. Forh. Christ. 1874, Tillægsh., p. 37; MALM, *Gbgs*, *Boh. Fn.*, p. 405; WINTH., *Zool. Dan.*, *Fiske.* p. 12, tab. II, fig. 8; ID., Naturh. Tidskr. Kbhvn, ser. 3, vol. XII, p. 10; COLL., Vid. Selsk. Forh. Christ. 1879, No. 1, p. 15; TILLIER, Mém. Soc. Nat. Sc. Natur., Math., Cherbourg, tom. XXII (1879), p. 265; DAY, *Fish. G:t Brit.*, *Irel.*, part. I, p. 62, tab. XXV; MOR. *Hist. Nat. Poiss. Fr.*, tom. II, p. 274; LILLJ., *Sv.*, *Norg. Fisk.*, vol. I, p. 172; MÖB., HCKE, *Fisch. Osts.*, p. 49; COLL., N. Mag. Naturv. Christ., vol. 29 (1884), p. 57.

Trigla Hirundo, LIN., *Syst. Nat.*, ed. X, tom. I, p. 301; *Fn. Suec.*, ed. II, p. 120; *Mus. Ad. Frid.*, tom. II prodr., p. 93.

Trigla Cuculus, BLOCH, *Fische Deutschl.*, part. II, p. 124, tab. LIX; CUV., VAL., *Hist. Nat. Poiss.*, vol. IV, p. 67; GTHR, Cat. Brit. Mus., Fish., vol. II, p. 207.

Trigla milvus, LACEP., *Hist. Nat. Poiss.*, vol. III, pp. 340 et 362 (adn. tamen *D.* 10 17; *A.* 15); BONAP., *Fn. Ital.*, *Pesci*, fasc. X, tab. 94, fig. 3; MOR., *Hist. Nat. Poiss. Fr.*, vol. II, p. 278.

Trigla Blochii, YARR., *Hist. Brit. Fish.*, ed. 2, vol. 1, p. 56; COUCH, *Hist. Fish.*, *Brit. Isl.*, vol. II, p. 29, tab. LXIX.

Trigla nigripes, MALM. Vide infra.

This fish is known by several names in the western islands: its most common name in Bohuslän is *Knot*, in Strömstad it is called *Halhös*. The name *Knorrhane* ("purring cock"), which is really Scanian, has arisen from the circumstance that, when drawn out of the water, the fish makes that purring sound the origin of which we have explained above.

The Grey Gurnard occurs along the whole of the west coast of Scandinavia. In the Baltic, according to NILSSON, it penetrates to the coast of Blekinge, and, according to WINTHER, to Christiansö (N. E. of Bornholm), though it is rare there, but fairly common west of Rügen. It is also known from the extreme north of Norway and from Iceland to Spain and Portugal, and also in the Mediterranean and the Adriatic Sea.

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[a] From 72 to 76, according to STEINDACHNER.

[b] At least the anterior: in full-grown specimens all.

[c] Sometimes the fifth ray too, according to TILLIER.

[d] More so in young specimens.

[e] From $^2/_{13}$ to $^2/_{11}$ of the length of the head to the tip of the lower opercular spine, according to STEINDACHNER. According to our measurements varying between 17 and 21 %, i. e. about 17 % (in young specimens) and from 18 to 21 % (in old), of the length of the head to the point of the opercular flap.

[f] According to our measurements varying between 27 % (in a specimen 70 mm. long) and 20 % (in a specimen 300 mm. long) of the length of the head to the point of the opercular flap.

[g] From $^4/_{19}$ to $^4/_{24}$ of the length of the body, according to TILLIER. These fins too, are comparatively longer in young specimens than in old, but their tip never extends behind the middle point of the length of the body.

The surface of the bones of the head is adorned with numbers of tuberculated lines, which radiate from certain points. The nostrils are situated in a slit, covered with skin, between the preorbital and nasal bones; the anterior is small and round, with a somewhat raised margin, the posterior larger, obliquely set and elongated. In the front part of the anterior margin of the eye are two or three sharp spines, and, in young specimens, a spine of equal size and also pointing in a backward direction, in the posterior part of this margin. Behind the eye, in young specimens in particular, a sharply defined, spinous ridge runs along the temple at the side of the occiput, and ends in a thick, sharp spine, belonging to the posttemporal bone. Similar, but smaller spines, also appear in the lower part of the hind margin of the preoperculum. In young specimens there are also distinct occipital spines, corresponding to those which are so characteristic of the preceding genus. The operculum is tipped with two sharp spines, the lower being the longer. The clavicular bone, too, is armed with a strong spine just above the pectoral fin. The ventral fins are inserted below or a little behind the pectoral, and in adult specimens are somewhat longer than the latter: in young specimens the reverse is sometimes the case. Of the three free rays of the pectoral fins the third is the longest and the first the shortest. When pressed close to the body, they are straight, but they form a geniculate curve, with the points turned backwards, when they are extended forward in a downward direction. In the first dorsal fin, which is of about the same height as the body and twice as high as the second, the third ray is usually the thickest and but slightly shorter than the second; but the rest diminish in length so sharply that the fin slopes suddenly in its posterior part. According to Lilljeborg the length of the longest rays in this fin, in adult specimens, is greater in the female than in the male, being about equal, in the former, to the distance from the tip of the snout to the hind margin of the orbit, and in the latter less than this distance[a]. The total number of rays in both dorsal fins varies between 27 and 29. The vent is somewhat, though sometimes only very slightly, in front of the middle of the body. The stomach is large and triangular, with thin walls. The intestinal canal forms two curves and is furnished with 7 pyloric appendages. The liver is small, and consists of two lobes: in young specimens it is relatively larger and more completely divided. The air-bladder is large, simple posteriorly and divided anteriorly into two, short, terete lobes.

In this fish, too, the coloration is very variable. Most often the upper part of the body is grayish yellow, strewn with bright, white dots, which below the lateral line sometimes unite into vermiform streaks, and the belly and lateral line white. In other specimens the white dots are surrounded by a small, black ring, which gives them the appearance of small *ocelli*. In others, again, there is no trace of these spots. Specimens also occur of a more or less dark, reddish brown colour, instead of the grayish yellow, and with the lateral line and the ventral sides strongly tinged with yellow. It is this colour-variety which we have represented in our figure, and which, if we are not mistaken, is rather a character of young specimens. The caudal, pectoral and dorsal fins adopt the colour of the body; the anterior of the latter pair is always the darker, and has a more or less distinct, blackish spot at the margin, between the third and fifth rays.

The Grey Gurnard attains a length of from 350 to 400 mm.[b] It is specimens of this size that are generally taken in Bohuslän. It lives at the same spots and in water of the same depth as the Haddock and Whiting, and is taken on the hook together with these fishes. According to Kroyer it is also occasionally taken by fishermen whiffing for Mackerel, even when the wind is so strong and the speed of the boat so great that the Mackerel does not bite readily. According to Couch it is a gregarious fish, and sometimes (during the spawning-season?), in fine summer-weather, collects in large shoals at the surface and slowly rises and sinks in the water, crooning, as if with pleasure.

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[a] Even if this sexual difference be restricted to specimens over 260 mm. in length, there are many exceptions. Among the numerous measurements on which the appended table is based, we have found that a male of *Trigla gurnardus* had one of the longest rays in the first dorsal fin and, at the same time, the shortest snout. Tillier (l. c.) has also failed to discover any constant external differences between the sexes in this species.

[b] According to Pennant (see Day) it may attain a length of $2\frac{1}{2}$ ft. (762 mm.).

MALM found ripe eggs in a female Grey Gurnard at the middle of July; and the fishermen assured him that this fish "has no (visible) roe, either in spring or in autumn." According to SARS the eggs float at the surface during their development[a].

This fish is eaten in Sweden as well as in other countries, though it is not considered a delicacy, as the flesh is somewhat flabby and insipid. There is no special fishery for it, however. Its food consists chiefly of shellfish, crustaceans and small fishes. MALM found the stomach of a female crammed with Sprats.

(FRIES, SMITT.)

Table showing partly the most important changes of growth in *Trigla gurnardus* and partly the relations between this species and the following one:

	Trigla gurnardus.		*Trigla lucerna.*		
	Average in four specimens from 70 to 116 mm in length	Average in four specimens from 213 to 300 mm in length	A young specimen from the Mediterranean	A specimen from Bohuslan	Average in the three specimens measured by MALM[b]
Length of the body from the middle of the tip of the snout to the middle of the hind margin of the caudal fin, expressed in millimetres	95.8	263.8	163	266	385
Length of the head to the tip of the opercular flap in % of the length of the body	26.8	27.1	27.6	26.8	26.0
,, ,, ,, ,, ,, ,, top of the hind margin of the preoperculum ,, ,, ,,	21.2	21.8	21.4	21.4	20.2
,, ,, ,, snout ,, ,, anterior margin of the orbit ,, ,, ,,	11.3	11.8	12.9	13.1	13.7
,, ,, ,, ,, ,, ,, anterior nostril ,, ,, ,,	4.9	4.9	5.4	5.6	5.2
Length of the body from the middle of the tip of the snout to the tip of the pectoral fins when folded ,, ,, ,,	44.6	44.4	53.4	52.6	51.6
Length of the pectoral fins ,, ,, ,,	21.6	19.9	28.8	28.2	
,, ,, ,, ventral ,, ,, ,, ,,	22.2	22.0	21.4	24.0	—
,, ,, ,, body from the middle of the tip of the snout to the vent ,, ,, ,,	42.1	45.0	46.0	45.9	46.9
,, ,, ,, base of the first dorsal fin ,, ,, ,,	13.8	14.4	16.6	15.6	—
,, ,, ,, ,, ,, ,, second ,, ,, ,, ,,	30.6	32.8	27.9	28.8	—
,, ,, ,, ,, ,, ,, anal ,, ,, ,, ,,	31.2	30.3	27.6	26.3	—
,, ,, ,, second ray in the first dorsal fin ,, ,, ,,	13.2	16.0	16.0	14.5	
Greatest depth of the body (at the beginning of the first dorsal fin) ,, ,, ,,	17.8	16.6	18.4	13.5	17.8
,, breadth ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,,	14.5	12.9	16.6	14.0	16.8
Least depth of the tail ,, ,, ,, ,,	3.4	3.5	4.3	4.0	4.3
Least breadth of the interorbital space ,, ,, ,, ,,	4.7	5.0	4.2	5.2	5.5
Longitudinal diameter of the eye ,, ,, ,, ,,	6.6	6.0	5.5	5.0	5.1

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[a] N. Mag. Naturv., Christ., B. 15 (1866), p. 126; and Ann. Mag. Nat. Hist., ser. 4, vol. 1 (1868), p. 390.

[b] *Gbgs., Boh. Fn.*, p. 403. The length of the specimens varies between 245 and 555 mm.

THE SAPPHIRINE GURNARD OR TUBFISH (SW. STORGNODINGEN[a] OR FENKNOTEN[b].)

TRIGLA LUCERNA.

Fig. 57.

Scales of the lateral line about 70[c] in number, weak, unarmed: scales of the body smooth at the margin. Marginal plates of the dorsal fin-groove 24 or 25 in number, smooth, with the posterior spinous point only slightly erected. Rays of the anterior dorsal fin smooth[d]. Length of the head to the point of the opercular flap from 25 to 27 % of that of the body. Length of the snout in young specimens less, in old specimens more, than $^{1}/_{2}$ that of the head. Breadth of the interorbital space, which is slightly concave[e], about $^{1}/_{5}$ or $^{1}/_{6}$[f] and the diameter of the eye about 20 %, of the length of the head[g]. Pectoral fins longer than the head[h], with blackish or bluish membrane on the outside and white or red rays, on the inside black, edged with blue or (usually only during youth) brownish-red with an oval, black spot, dotted with milk-white spots (var. *poeciloptera*). *Upper part of the body red.*

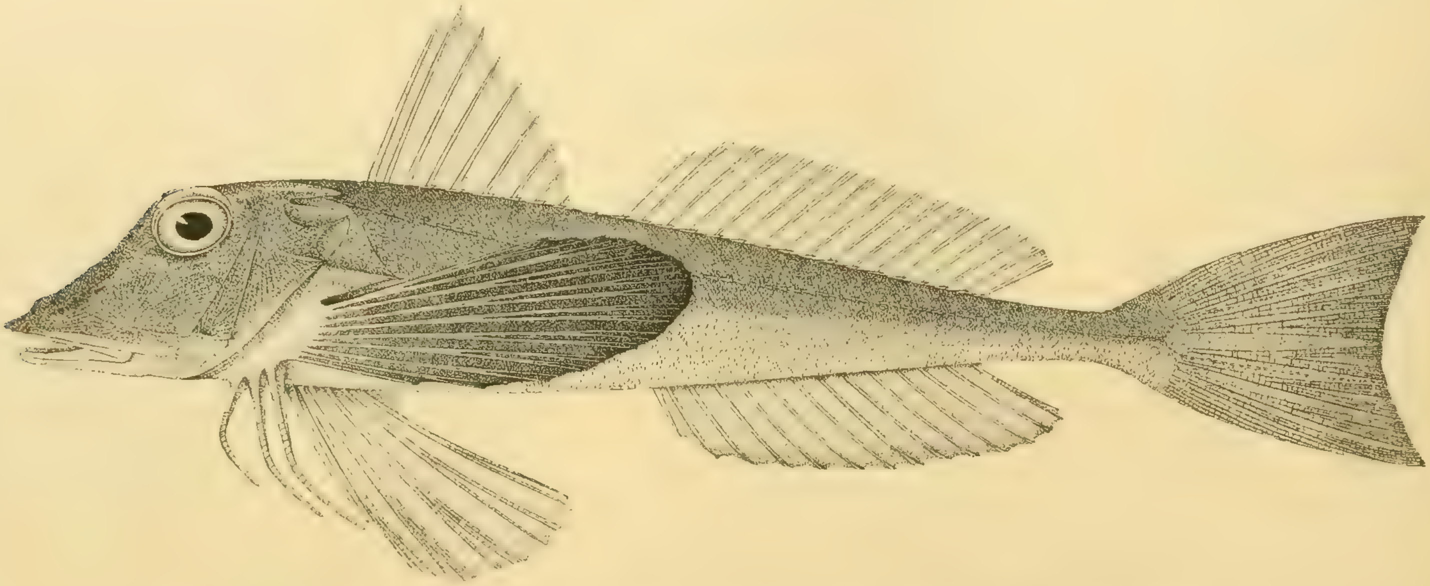

Fig. 57. *Trigla lucerna*, $^{2}/_{3}$ of the natural size, from Strömstad, taken by Mr. C. A. Hansson, 1887.

R. br. 7; *D.* 8 l. 9 16 l. 17[i]: *A.* 14—16: *P.* (1 + 7 + 3)[j] + 3: *V.* $^{1}/_{5}$; *C.* *x* + 9 + *x*.

Syn. *Corax* (§. IV), *Hirundo* (§. V), *Lucerna* Venetorum (§. VI), Willughby (ed. Raii), pp. 280 et 281. *Trigla*, No. 5 et No. 6, Art., *Gen. Pisc.*, pp. 44 et 45: No. 4 (*Hirundo*, Will.) et No. 5 (*Lucerna*, Will.), *Syn. Pisc.*, p. 73.

Trigla Lucerna, Lin., *Syst. Nat.*, ed. X, tom. I, p. 301 (— Art., *Trigla*, No. 6 in *Gen.*, No. 5 in *Syn.*).

Trigla Hirundo, Bloch (p. p.), *Naturg. Fisch. Deutschl.*, part. II, p. 126, tab. LX; Cuv., Val., *Hist. Nat. Poiss.*, vol. IV, p. 40; Nilss., *Prodr. Ichth. Scand.*, p. 88; Kroy., *Danm. Fiske*, vol. I, pp. 106 et 581; Yarr., *Brit. Fish.*, ed. 2, vol. I. p. 47: Nilss., *Skand. Fn.*, *Fisk.*, p. 59: Gthr, *Cat.*

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[a] Nilsson, *Skand. Fauna.*

[b] Malm, *Gbgs, Boh. Fauna.*

[c] We have found the number of the tubiform ducts of the lateral line to be either 69 or 72.

[d] In exceptional cases Tillier (l. c.) has found a few tubercles at the base of the anterior margin of the first ray.

[e] More so in young specimens.

[f] From $^{1}/_{6}$ to $^{4}/_{21}$ of the length of the head to the tip of the lower opercular spine, according to Steindachner. According to our measurements varying between 15 % (in young specimens) and 22 % (in old) of the length of the head to the point of the opercular flap.

[g] According to our measurements and those of Prof. Malm, varying between 22 or 20 % (in specimens from 160 to 250 mm. long) and 19 or 18 % (in specimens from 250 to 550 mm. long) of the length of the head.

[h] From 28 to 30 % of the length of the body, and with the tip always extending beyond the middle of the body when they are folded; also longer than the base of either the second dorsal or the anal fin.

[i] Sometimes 15, sometimes 18, according to Steindachner and Tillier.

[j] (1 + 8 + 2) + 3, according to Steindachner. Sometimes 9 or 12 + 3, according to Collett.

Brit. Mus., Fish., vol. II, p. 202; Couch, *Fish. Brit. Isl.*, vol. II, p. 21, tab. LXV; Steind., Stzber. Akad. Wiss. Wien, LVI, 1 (1867), p. 683; Coll., Vid. Selsk. Forh. Christ., 1874, Tillægsh., p. 37; Ltkn, Vid. Meddel. Naturh. For. Kbhvn. 1876, p. 388; Malm, *Gbgs, Boh. Fn.*, p. 398; Winther, *Zool. Dan., Fiske*, p. 13, tab. II, fig. 9; Id., Naturh. Tidskr., Kbhvn, ser. 3, vol. XII, p. 10; Coll., Vid. Selsk. Forh., Christ., 1879, No. 1, p. 15; Tillier, Mém. Soc. Nat. Sc. Natur., Math., Cherbourg, tom. XXII (1879), p. 272; Day, *Fish. Gt. Brit., Irel.*, part. I, p. 59, tab. XXIV; Lillj., *Sv., Norg. Fiskar*, vol. 1, p. 182; Möb., Hcke, *Fisch., Osts.*, p. 50.

Trigla lævis, Montagu, Mem. Wern. Nat. Hist. Soc., vol. II, p. 455.

Trigla pœciloptera, Cuv., Val., l. c., p. 47; vide Steind. et Ltkn, l. c.

Trigla corax, Bonap., *Fn. Ital., Pesci*, fasc. X, p. 52, tab. 94, fig. 1; Mor., *Hist. Nat. Poiss., Fr.*, tom. II, p. 284.

Trigla nigripes, Malm, Förh. Skand. Naturf. M., Stockh. 1863, p. 410; *Gbgs, Boh. Fn.*, p. 403; Gbgs Nat. Hist. Mus. Årsber. III (1881), p. 22.

Obs. As there can be no doubt as to the identity of Willughby's *Lucerna Venetorum*, and as Linnæus has misapplied the name *Hirundo* — in his works the same species as *Gurnardus* — it is evident that, according to the current rules of nomenclature, this species should be called *Trigla lucerna*. Even in Bloch we find several remarks which clearly show that he has confounded this species with the preceding one; and should we refuse to recognise the specific name *lucerna*, on the grounds that it has also been misapplied, Montagu is the first post-Linnæan writer who has given the species an accurate name and definition.

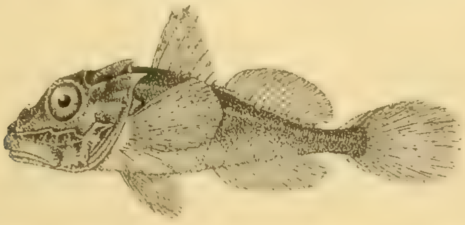

Fig. 58. *Trigla nigripes*, taken on the 26th of August, 1872, off Marstrand. A. W. Malm. Magn. 3 diam.

Malm's *Trigla nigripes* has been referred by Collett and Lilljeborg to the preceding species, as a young specimen thereof. This opinion is borne out by the strange circumstance pointed out by Malm himself, that he had never found the fry of *Trigla gurnardus* on the coast of Bohuslän, but, if his own later opinion be correct, had met with young specimens of the much rarer *Trigla lucerna*. Esmark, however, according to Collett, at a more recent date obtained in Christiania Fjord young specimens of the latter species, so small that we must assume that it also propagates in Scandinavian waters. Hence we must pay more attention to Malm's reference to the number of rays in the anal fin of *Tr. nigripes*, which is too small to apply to a *Tr. gurnardus*. By Mr. Stuxberg's kind permission I have been enabled to examine two of Malm's type-specimens, one of which is figured here (fig. 58), and to verify his statements as to the number of rays in the dorsal fins (9(8) 16) and the anal fin (15), and of spinous plates at the margins of the dorsal fin-groove (23 — though in the anterior part two more are to be found, though only rudimentary), and also his observations as to the Cottoid characters which give this larval stage its especial interest. The question of species must remain undecided, however, until it has been shown that the number of rays cannot undergo during growth the requisite increase to admit of the inclusion of these young specimens in the preceding species, or that the spines which here mark the lateral line, as well as the two nasal spines, which also remind us of the *Cotti*, are evanescent, juvenile characters. These young specimens are further distinguished by 6 large muciferous pores beneath the eye, arranged in a row from the snout along the cheek and superiorly bounded by a raised bony ridge, which is continued posteriorly in a curve to the upper preopercular spine. We find a corresponding structure to these muciferous pores in the *Cotti*, e. g. in *Cottus quadricornis;* but they appear with a still more striking likeness in the genus *Agonus* of the following family.

The Sapphirine Gurnard is principally distinguished from the preceding species by its weaker scales, deeper tail, longer snout and longer pectoral fins: the anal fin, as well as the second dorsal, on the other hand, is shorter and contains fewer rays. The base of the first dorsal fin is more than half the length of the base of these two fins; but its height is about the same as in the preceding species. The scales of the lateral line are scarcely apparent, but the lateral ducts into which the canal branches, in young specimens at least, are all the more distinctly visible. These ducts are generally four in number, at least in the anterior part of the line, two running upwards and two downwards from the main duct in each scale. The least depth of the tail is at least 15 % of the length of the head, which is about equal to the length of the base of the anal fin, or even exceeds it. The length of the snout, which in old specimens is more than half that of the head, even in young specimens measures more than 45 % of the length of the base of the anal fin. The length of the pectoral fins is always greater than that of the ventral, and their middle rays are triply bifid, a character remarked even by Willughby. Another distinction between this species and the preceding one lies in the granular striation of the large suborbital bone (the cheek). These raised striæ, which here, as on the other external bones of the head, radiate from a centre, have this centre set so low down that, as a rule, no striæ (probably in young specimens only) run downwards therefrom; but one or two striæ, which are thicker than the rest, run up from this point towards the lower, anterior corner of the orbit, and another, rising into a sharp edge, runs straight backwards and is continued on the surface of the preoperculum out to the superior marginal spine at the corner of this bone.

The coloration of the Sapphirine Gurnard is far more remarkable than that of the preceding species. The back, according to Krøyer, is usually red (seldom grayish) with a dash of brown or green, and the sides a lighter orange with a more or less distinct, golden lustre. The orange colour sometimes forms a longitudinal stripe, separated by a white streak from the deeper colour of the back. The ventral side white, sometimes with a dash of rose-colour. The dorsal, anal and ventral fins orange, the caudal fin blackish gray tinged with blood-red. The pectoral fins externally blackish blue, with orange or bluish white rays, according to DAY, reddish with blue margins. On the inside of these fins we sometimes find at the lower margin a large, black spot, strewn with small spots of milky white or light blue. This colour on the inside of the pectoral fins is not fast, however, and leaves stains when touched (cf. MALM).

The Sapphirine Gurnard is a rare fish in Scandinavian waters, though its geographical range is about as wide as that of the preceding species, solitary specimens being met with as far north as Lofoden. As STEINDACHNER states that the *Trigla capensis* of VALENCIENNES belongs to the same species, the range of the Sapphirine Gurnard must extend south at least as far as the Cape of Good Hope. Strangely enough, according to MALM, it apparently occurs in the Skager Rack and the Cattegat more frequently in some years than in others. In 1860, for example, the Museum of Gothenburg received eight specimens, and in 1869 four; with these exceptions MALM had not met with this species on the coast of Bohuslän for thirty years. In 1886 Mr. C. A. HANSSON obtained a specimen, which had been caught in Strömstad Fjord in the month of July, and in 1887 another, which had been caught in the same place in December. Though it penetrates into the Sound and has been taken in Kiel Bay (MÖB., HCKE), this happens very seldom, generally in autumn and winter. It may, therefore, be regarded only as an occasional visitor to the Cattegat, though MALM'S and ESMARK'S observations which we have mentioned above, show that it may propagate its species even in the Skager Rack.

The Sapphirine Gurnard attains a larger size than the preceding species. According to MOREAU its length may be as great as 600 mm. — a specimen taken in Christiania Fjord, in November, 1869, was 620 mm. long, according to COLLETT — and according to THOMPSON (see DAY, l. c.), it may weigh as much as 14 lbs. Its manner of life is probably the same in the most essential respects as that of the preceding species; and the spawning-season proper also occurs probably in the summer, though COUCH found specimens with ripe roe both at Christmas and from May to July. The greater size of the pectoral fins in this species, however, reminds us of its more pronounced habit of leaping out of the water, which in some places, according to NILSSON, has given it the name of "Flying-fish," and which, says LACÉPÈDE[a], is connected, to a certain extent, with the name of *lucerna* (*"lanterne ou fanal"*). "It is chiefly the parts of the head," he says, "especially the gape and, above all, the palate, which shine at night with a pleasing and steady light, like that which radiates from so many phosphorescent objects, living or dead, during the lovely summer-nights of the South. After sunset, on a calm evening, one may see hundreds of Gurnards, exposed to the same danger and impelled by a common panic, leap out of their element to avoid a dangerous foe, and spring into the lower aerial regions, where they support themselves for some moments by flapping their membranous wings, which are short, but wielded by strong muscles. It is a strange sight — these soft lights which suddenly rise above the waves, advance and again fall into the depths, after tracing in the air interlacing lines of fire, now distinct and now united. Helped by the phosphorescent gleam of the water at the surface, they thus form in the air an illumination which moves on and varies without a pause."

FAM. AGONIDÆ.

Body cottiform but elongated, and cuirassed with contiguous, bony plates, arranged in from 8 to 10 longitudinal rows. Spinous-rayed part of the dorsal fins (which is sometimes wanting) usually shorter (but sometimes longer) than the soft-rayed. Anal fin without spinous rays. Ventral fins with 1 spinous and 2 or 3 soft rays. Rays of the pectoral fins, like those of the other fins, usually simple. Pseudobranchiæ present. No air-bladder. Vertebræ more than 30.

As we have mentioned above, the forms within this family, the *Cuirassed Gurnards*, are so closely related to the preceding ones that some writers regard both the Flying Gurnards and the Malarmats as Cuirassed

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[a] *Hist. Nat. Poiss.*, tom. III, p. 363.

Gurnards. But the absence of the air-bladder, the undivided pectoral fins without free rays at the bottom, the somewhat singular form of the body, and the situation of the vent, which lies far in front of the end of the abdominal cavity, nearer the ventral fins than the anal fin, are all in favour of the procedure of GILL[a], and after him of JORDAN and GILBERT[b], who isolated these fishes under the family name of *Agonidæ*, which was first employed by SWAINSON[c]. The body is of the typical Cottus form, with the head thicker than the body, which tapers posteriorly in a conical form, but is sometimes so elongated and low that, with its few rows of plates, it reminds us of the *Syngnathi*. Its resemblance to the latter is further increased by the longitudinal curvature of the plates on the trunk, which are traversed by a keel at the middle, on the outside of the curve. Sometimes, too, as in the genus *Siphagonus*, the snout, with the projecting lower jaw, is almost tubular and resembles that of *Syngnathus*. Sometimes, however, as in the genus *Bothragonus*, the body is laterally more strongly compressed and fairly deep and short. The variations of form within the family are thus by no means inconsiderable. The eyes are set high, but on the sides of the angular and lacunose head; and on the lower part of the cheek we find the row of muciferous pores, belonging to the system of the lateral line, which we have remarked above in the fry of the Sapphirine Gurnard. The strange appearance of the head is often enhanced by the elongation of the snout into a kind of proboscis, and by the spines on the upper surface of the latter; and numerous barbels are sometimes attached to the lower side of the head. Behind the fourth branchial arch the gill-slit has disappeared; and the pseudobranchiæ are well-developed. The jaw-teeth are small and cardiform; and similar teeth sometimes occur on the palatine bones and the vomer as well. The ventral fins, with one spinous and two or three soft rays, are set fairly close together and somewhat behind the insertions of the pectoral fins. As a rule, there are two dorsal fins, the anterior with spinous rays; but sometimes, in the genus *Aspidophoroides*[d], this last fin is wanting.

The systematical, as well as the morphological, relations between the genera are explained, in this family as in others, by the changes of growth in the species, which changes have already been described by STEENSTRUP and LÜTKEN[e]. The most remarkable of these changes is the gradual removal in a forward direction of the vent — in a specimen of *Agonus decagonus*, 76 mm. long, from Greenland, we find 8 pairs of plates between the vent and the beginning of the anal fin, in another, 162 mm. long, 10 plates on the left side and 11 on the right; in a specimen of *Agonus cataphractus*, 93 mm. long, from Bohuslän, there are 5 plates on the right side and 6 on the left, between the vent and the anal fin, in a specimen 121 mm. long, 6 on each side, and in a specimen 178 mm. long, 7 pairs of plates on this space. Another change lies in the elongation of the tip of the snout, and the elevation, or even the protrusion, of the nasal spines. Young specimens are without the marked elongation of the nasal bones in a forward direction, in front of the original tip of the snout, or even (as in *Agonus decagonus* juv. = *Ag. spinosissimus*) have the lower jaw more protruded than the upper. The form of the body in these species begins its changes with the relatively shorter (deeper) form in young specimens than in old, and with the deeper caudal region, which is even laterally compressed. In young specimens of both the Scandinavian species of *Agonus*, the middle keels of the plates on the body and the ridges of the head are higher, and rise into spines pointing in a backward direction, even in the species (*Ag. cataphractus*) which in the adult state can scarcely be called spinous, so rounded and blunt have these plates and ridges become. The genera which, when full-grown, are distinguished by the deeper form of the body, by higher spines on the plates, by the shorter (more obtuse) form of the tip of the snout or by the rising (projecting) tip of the lower jaw, may thus be regarded as representatives of the earlier (lower) stages of development. It also seems probable that the palatine and vomerine teeth are subject to similar changes and disappear with increasing age, for traces of teeth (small and to be distinguished only by the touch) occur, in exceptional cases, on the vomer in *Agonus decagonus*. We have, however, no further observations on this point.

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[a] *Arrang. Fam. Fish.*, Smiths. Misc. Coll. No. 247, p. 6: *Cat. Fish. E. Coast N. Amer.*, ibid., No. 283, p. 2.

[b] *Syn. Fish. N. Amer.*, Bull. U. S. Nat. Mus., No. 16, p. 722.

[c] *Nat. Hist., Class. Fish. Amph., Rept.*, (Lardn. Cab. Encycl.), vol. II, pp. 181 and 272.

[d] One species of this genus, *A. Olrikii*, has been found both in Greenland and in Kara Sea (LÜTKEN in *Dijmphna-Togtet*, p. 120), and may possibly occur, therefore, in the deep water off the extreme north of Norway, though it is just as probable that its range extends west only from Greenland to Nova Zembla. A specimen 65 mm. in length, was taken by the Vega Expedition at a depth of 18 fathoms, in Behring Strait (64° 52′ N.; 172° 3′ W.)

[e] Vid. Meddel. Naturh. For. Kbhvn 1861, p. 276.

The family belongs chiefly to the depths of the Arctic seas — one genus, however, *Agonopsis*, with two dorsal fins and both vomerine and palatine teeth, belongs to the Antarctic fauna. The true haunt of these fishes is apparently the soft, clayey bottom, where they feed on all kinds of small animals and often fall a prey to the Halibut, being subsequently found in its stomach. Some species, however, ascend nearer the surface. JORDAN and GILBERT estimate the number of species at about 16. In the Scandinavian fauna only one genus occurs.

GENUS **AGONUS.**

Two dorsal fins. Palatine bones and vomer toothless. Tip of the snout projecting in front of the lower jaw. Caudal region elongated and low.

Thus defined[a], the genus *Agonus*, which was established by BLOCH[b], includes GILL's genus *Podothecus*[c]. According to this opinion four species are known, two of which belong to the northern parts of the basin of the Atlantic and two live in the corresponding parts of the Pacific. The first two may be most easily distinguished by the different number of pairs of plates (posteriorly forming only one row) from the occiput to the caudal fin:

A: Number of paired and unpaired plates in a row on the back from the occiput to the caudal fin above 40... *Agonus decagonus*.
B: Number of paired and unpaired plates in a row on the back from the occiput to the caudal fin under 37... *Agonus cataphractus*.

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[a] Cf. STEINDACHNER. Stzber. Akad. Wiss. Wien, LXXXII (1880), I. p. 255.

[b] *Blochii Syst. Ichthyol.*, ed. SCHN., p. 104. One year later (1802) LACÉPÈDE (*Hist. Nat. Poiss.*, tome III, p. 221) entitled this genus *Aspidophorus*.

[c] Proc. Acad. Nat. Sc. Philad. 1861, p. 259.

AGONUS DECAGONUS.

Fig. 59.

Form of the body very elongated, shallow and narrow: number of paired and unpaired plates in a row on the back from the occiput to the caudal fin above 40[a]*; least depth of the tail, in adult specimens, 2 % (or slightly more) of the length of the body and at most 10 % (or slightly more) of the length of the head; breadth of the body at the base of the pectoral fins less than 16 % of its length or than 75 % of the length of the head. Ridges on the head and on the plates of the body, even in adult specimens, raised into spines pointing in a backward direction. The two dorsal fins quite distinct; at least 3*[b] *pairs of plates on the back between them. First dorsal fin set rather far forward; the distance between it and the tip of the snout less than 30 % of the length of the body, and the length of the head more than 70 % of this distance. Eyes large: the longitudinal diameter greater than the least breadth of the interorbital space and also more than 5 % of the length of the body, while the least depth of the tail, in adult specimens, is less than 40 % of this diameter. Only two nasal spines*[c]*. About 5 barbels, simple or branched, on each side of the head, one on each side of the lower jaw and three or four on the dermal fold at the corner of the mouth; none on the branchiostegal membrane, in the middle of which (below the isthmus) small plates, each with a tubercle at the middle, are set so as to form an angle (∧).*

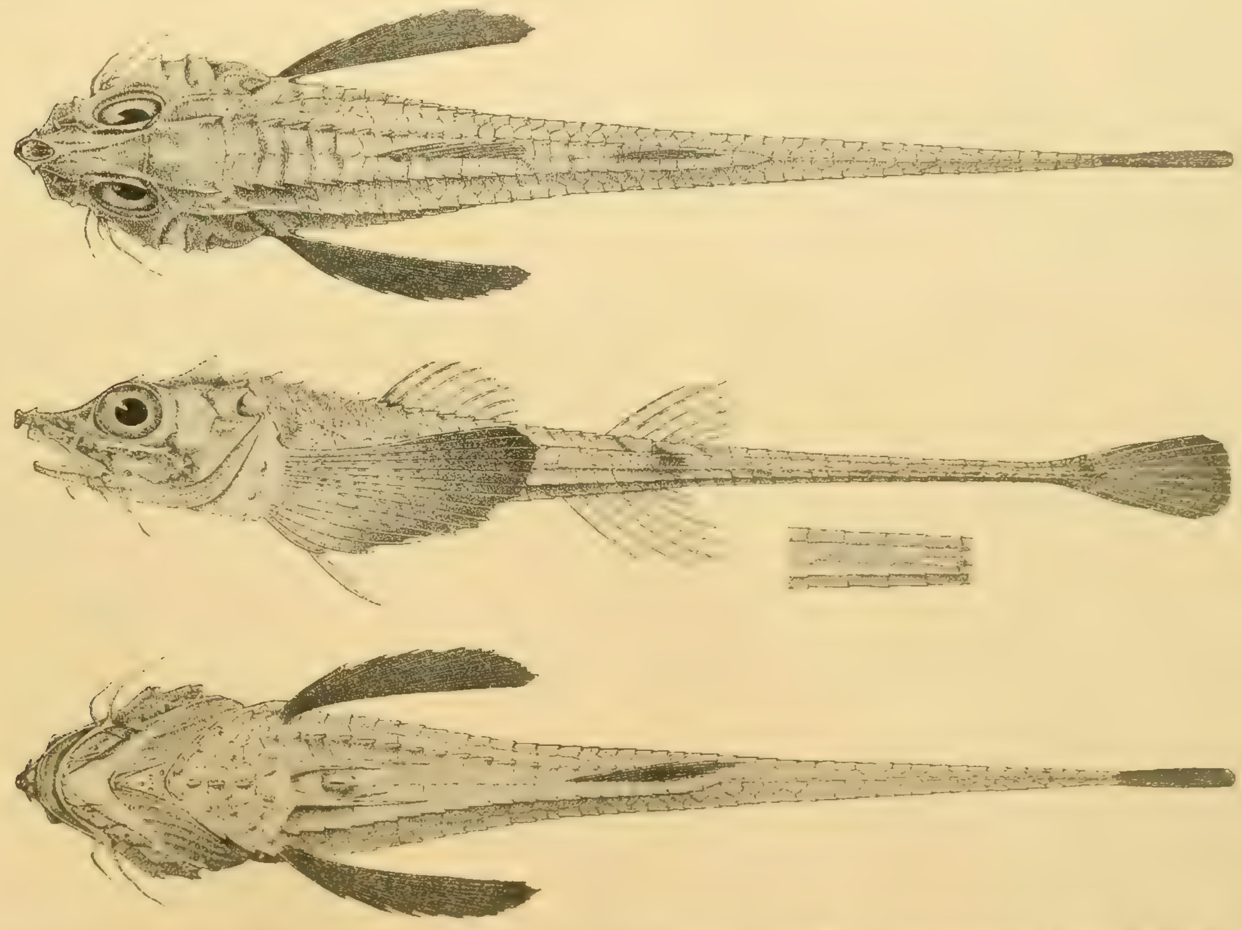

Fig. 59. *Agonus decagonus*, seen from above, from the side and from beneath, natural size, together with a part of the tail, seen from the side and magnified to show the pores of the lateral line. Specimen from North Fjord off Disco (Greenland), taken at a depth of 146 fathoms on a loose, clayey bottom, on the 10th of July, 1871. JOSVA LINDAHL.

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[a] 41—45, according to LÜTKEN: 43 or 44 in the specimens belonging to the Royal Museum.

[b] 3—5, according to COLLETT: 3 or 4 in the specimens belonging to the Royal Museum.

[c] Corresponding to the posterior pair in the following species. In adult specimens, however, there are two blunt protuberances on the anterior part of the tip of the snout.

R. br. 6: *D.*[a] 7 6—8: *A.*[b] 7 l. 8: *P.*[c] 16: *V.* $^{1}/_{2}$: *C.*[d] $x+7+x$: . *lat. por.*[e] 25—29.

yn. *Cottus cataphractus*, Fabr., *Fn. Groenl.*, p. 155 (nec Lin.).

Agonus decagonus, Bl., *Syst. Ichthyol.*, ed. Schn., p. 105, tab. 27; Cuv., Val., (*Aspidophorus*) *Hist. Nat. Poiss.*, IV, p. 223; Reinh., Dan. Vid. Selsk. Naturh., Math. Afh., V, Overs. 1829—1830, p. LIII; ibid. VII, pp. 114 et 119; Kr., Naturh. Tidskr. Kbhvn, ser. 2, vol. I, p. 243; Id., *Voy. Scand., Lapp.*, Gaim., *Poiss.*, tab. 5, fig. 1; Nilss., *Skand. Fn., Fisk.*, p. 88; Gthr, (*Agonus*) *Cat. Brit. Mus., Fish.*, II, p. 215; Mgrn, (*Aspidophorus*), *Finl. Fiskfn.*, (disp.), p. 12; Id., Öfvers. Vet.-Akad. Förh. 1867, p. 260; Gill, (*Archagonus*) *Cat. Fish. E. Coast. N. Amer.*, Smiths. Misc. Coll., No. 283, p. 22; Coll., (*Agonus*), Vid. Selsk. Forh., Chrnia 1874, Tillægsh., p. 40; Ltkn, Vid. Meddel. Naturh. For. Kbhvn 1876, p. 381; Coll., Norske Nordh. Exped., Zool., Fiske, p. 44, tab. II, fig. 11 et 12; Lillj., *Sv., Norg. Fisk.*, I, p. 193; Jord. (*Agonus, Podothecus*) Proc. Acad. Nat. Sc., Philad., 1883, p. 293.

Aspidophorus spinosissimus, Kr., Naturh. Tidskr., l. c., p. 250; *Voy. Scand.*, l. c., fig. 2; Gill (*Leptagonus*), Proc. Acad. Nat. Sc. Philad. 1861, p. 167; — form. juv. demonstr. Steenstr., Ltkn, Vid. Meddel. Naturh. Forh. Kbhvn 1861, p. 280.

Aspidophorus malarmoides, Eud., Desl., Mém. Soc. Linn. Norm., tom. 9, p. 167.

According to the above remarks on the mutual re-tions of the forms within this family, *Agonus decagonus*, ı form of body, occupies a higher place in the scale f development than the following species; but in most ther respects it remains at a lower stage. The former haracter is most clearly expressed, as usual, by the roportions of which the least depth of the tail is a actor; and, connected with the elongated form of the ody, we find the comparatively large number of plates ı the longitudinal rows. These rows are anteriorly 8 ı number, but on the tail, a little behind the second orsal and the anal fin, are reduced to 6, owing to the onfluence of the two neighbouring rows on the back nd the under side of the tail. On the back there are or 6 plates in front of the first dorsal fin, which tself extends along 8 or 9 plates; then 3 or 4 (some-imes 5 according to Collett) similar pairs of plates etween this fin and the second dorsal, which generally xtends along 7 plates. Behind this point 2 pairs of lates may generally be distinguished, and then the wo rows coalesce, at first retaining a longitudinally livided, superior ridge on the plates, the number of vhich we have found to be 18 or 16 (from 14 to 17 ccording to Lütken) in this simple dorsal row to the base of the caudal fin. The anterior part of the lateral line of the body is furnished with about 5 (in young specimens) or 7 (in old) smooth, scaly plates, which it pierces in the ordinary way; and during this part of its course the lateral line slopes down from the upper corner of the gill-opening almost to the middle of the side, vertically below the beginning of the first dorsal fin, the point at which the upper of the two lateral rows of spinous plates begins, while the lower has already begun at the middle of the axil of the pectoral fin. The lateral line now rounds the upper lateral row of plates and runs along the middle of the side to the base of the caudal fin. At the beginning of its course between the two lateral rows of plates it still opens into a pore at each of the first two (perhaps three) plates; but then these ducts become elongated and run in the form of small lateral tubes along the lower side of the lateral line proper, opening only at every second or every third plate. Hence it follows that when, for example, we can count 42 spinous plates in the lower lateral row, we can find only 29 pores in the lateral line. On the head the system of the lateral line is furnished with large muciferous pores, both under the lower margin of the suborbital bones and in the lower posterior margin of the preoperculum, where four corner-spines (most distinct in young specimens) — the uppermost (hindermost) pointing backwards and upwards, the corner-spine itself backwards and downwards, the next downwards, and the first one forwards and downwards — form the boundaries of the muciferous pores between them, which are continued, as usual, in a row on the lower side of the branches of the lower jaw. The anterior nostrils are fairly large, cylindrical, dermal ducts, turned outwards and set about half-way along the snout; the posterior, on the other hand, are extremely small and very slightly raised ducts, set just in front of the lower part of the anterior osseous boundary of the orbit (the ectethmoid bones). Just in front of the posterior nostrils lies a small round hole or slightly raised opening pore of the large muciferous canal which belongs to the system of the lateral line on the head. This canal is a continuation, on each side of the snout, of the frontal and occipital muciferous canals, which are furnished with small, raised, tubular openings, on the forehead between the supra-orbital spines and on the occiput between the occipital spines, respectively. The ventral fins, which in their structure with only two soft rays and with the spinous ray hidden in the connexion between it and the outer soft ray — remind us of certain species among the *Cotti*, also give us a sexual distinction, as LÜTKEN was the first to point out, which likewise calls to mind the *Cotti*. In the males the outer soft ray is considerably elongated, measuring somewhat more than 11 % of the length of the body or about half the distance from the insertion of these fins to the beginning of the anal fin; while in the females the length of the ventral fins is much less, being only slightly more than, or equal to, the longitudinal diameter of the eye.

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[a] D_1. 5 or 6, according to Lütken; 5—7, according to Collett.

[b] *A.* 5—8, according to Lütken.

[c] *P.* 14—16, according to Collett.

[d] All the rays simple; 3—5 supporting rays above, and 2 or 3 below the 7 middle rays.

[e] *L. lat.* por. 23—25, according to Collett.

Agonus decagonus attains a length of at least 21 cm. It is an arctic form, first discovered in Greenland, and subsequently found by O. TORELL in Beru Fjord (Iceland) and by the Finnish explorers NYLANDER and GADD in Varanger Fjord (Norwegian Finmark). It was found by the Norwegian Arctic Expedition of '76—78 at a considerable depth (between 123 and 260 fathoms) and in very cold water (+34·7 Fahr. to +30·2 Fahr.), on clayey and stony bottoms, in the Arctic Ocean round Bear Island and Spitzbergen. The Swedish Expedition of 1868 found young specimens, 21 mm. in length (in all probability not more than a month old), near the surface, where the water was 3 or 4 fathoms deep, in Liebde Bay, Spitzbergen, on the 29th of August. One of these specimens is here figured.

In this species, as in the following one, the colouring is distributed according to the typical arrangement in *Cottus*. It is yellowish gray, with dark transverse bands, the situation of which is more minutely shown in the figure (p. 205).

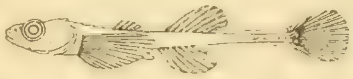

Fig. 60. Young specimen of *Agonus decagonus*, Liebde Bay (Spitzbergen), taken at the surface, 29th Aug., 1868. MALMGREN and SMITT.

Instead of giving a more detailed description we may refer to the following table, which gives the most important relations of form in the two specimens of the Royal Museum from Greenland, side by side with which we have set the corresponding measurements in three specimens of the following species. We may here trace the tendency of the changes of growth and the consequent relative position of the two species, as well as the respects in which constant specific characters appear, to judge by the materials at our disposal.

	Agonus decagonus from Greenland.		*Agonus cataphractus*		
			from Bohuslän.	from Hammerfest.	from Bohuslän.
Length of the body expressed in millimetres	76	162	93	121	178
„ „ „ head in % of the length of the body	21.3	21.3	21.5	21.5	20.8
Longitudinal diameter of the eye	5.5	5.5	4.8	4.3	3.9
Distance between the first dorsal fin and the tip of the snout	28.3	29.6	32.2	33.9	33.2
Distance between the insertion of the ventral fins and the beginning of the anal fin	19.5	22.4	23.9	25.0	25.5
Least depth of the tail	2.1	2.0	3.1	3.3	2.8
Breadth of the body across the base of the pectoral fins	12.5	14.2	17.1	19.9	20.3
Depth „ „ „ at the beginning of the first dorsal fin	10.5	12.7	12.7	13.7	13.7
Least depth of the tail in % of the length of the head	9.9	9.3	14.5	15.4	13.5
„ „ „ „ „ „ „ „ „ longitudinal diameter of the eye	38.1	35.5	64.4	76.9	71.4
„ „ „ „ „ „ „ „ „ least breadth of the interorbital space	42.1	40.0	58.0	66.7	53.7
„ „ „ „ „ „ „ „ „ length of the lower jaw	23.5	20.0	48.3	40.0	35.7
„ „ „ „ „ „ „ „ „ distance between the first dorsal fin and the tip of the snout	7.4	6.7	9.7	9.7	8.5
„ „ „ „ „ „ „ „ „ height of the first dorsal fin		26.7	32.2	—	38.4
„ „ „ „ „ „ „ „ „ „ „ „ second „ „	—	18.8	35.3	—	34.5
„ „ „ „ „ „ „ „ „ length of the base of the anal fin	18.2	22.8	27.3	30.0	23.5
Distance between the insertion of the ventral fins and the beginning of the anal fin in % of the distance between the anal fin and the tip of the snout	47.1	49.6	53.1	54.1	55.5
Breadth of the body across the base of the pectoral fins in % of the length of the head	59.2	66.7	78.5	92.3	97.3
Length of the ventral fins in % of the length of the pectoral fins	45.1	51.5	55.0	68.2	62.1
„ „ „ „ „ „ „ „ „ distance between the insertion of the ventral fins and the beginning of the anal fin	40.5	49.8	54.5	49.5	45.0
Length of the head in % of the distance between the first dorsal fin and the tip of the snout	75.3	71.9	66.7	63.4	62.7

THE BEARDED COTTUS (SW. SKÄGGSIMPAN OR BOTTENMUSEN.)

AGONUS CATAPHRACTUS.

Plate V, fig. 1.

Body elongated, but less so than in the preceding species: number of paired and unpaired plates in a row on the back from the occiput to the caudal fin less than 37[a]*; least depth of the tail more than 2$^1/_2$ % of the length of the body and at least 13 % of the length of the head; breadth of the body across the base of the pectoral fins more than 16 % of the length of the body or than 75 % of the length of the head. Ridges of the head (with the exception of those of the cheek and the preoperculum) and the plates of the body, in adult specimens, obtuse, not raised in a spinous form. The two dorsal fins only a slight distance apart or even contiguous. Distance between the first dorsal fin and the tip of the snout about 33 %*[b] *of the length of the body; and the length of the head less than 70 % of this distance. Longitudinal diameter of the eye, in full-grown specimens, less than the least breadth of the interorbital space and also less than 5 % of the length of the body; and the least depth of the tail more than 60 % of this diameter. Two pairs of nasal spines. One or two pairs of barbels on the lower side of the snout; in most cases three barbels at each corner of the mouth and three on the posterior part of the cheek; numerous barbels throughout the branchiostegal membrane on the lower side of the head.*

R. br. 6; *D.* 5 | 6 6—8; *A.*[c] 6 | 7; *P.*[d] 16; *V.* $^1/_2$; *C.*[e] $x+7+x$; *L. lat. por.*[f] 37—40.

Syn. *Cataphractus*, SCHONEV., *Ichth. Slesv., Hols.* (Hamburgi 1624), p. 30; *Cottus cirris plurimis, corpore octagono*, ART., *Gen.*, p. 49; *Syn.*, p. 77; *Spec.*, p. 87.

Cottus cataphractus, LIN., *Mus. Ad. Fried.*, I, p. 70; *Syst. Nat.*, ed. X, tom. I, p. 264; *Fn. Suec.*, ed. II, p. 115; RETZ., *Fn. Suec. Lin.*, p. 327; FABER, *Fische Isl.*, p. 117; NILSS., (*Agonus*) *Prodr. Ichth. Scand.*, p. 95; PALL., (*Phalangistes*) *Zoogr. Ross. As.*, vol. III, p. 113; KR., (*Aspidophorus*) *Danm. Fiske*, vol. I, p. 143; EKSTR. et WRIGHT, *Skand. Fisk.*, ed. I, p. 167, tab. 40; NILSS., *Skand. Fn., Fisk.*, p. 86; GTHR (*Agonus*), *Cat. Brit. Mus., Fish.*, vol. II, p. 211; STRP., LTKN, (*Aspidophorus*), Vid. Medd. Naturh. For. Kbhvn 1861, p. 277; COLL. (*Agonus*), Vid. Selsk. Forh. Chr. 1874, Tillægsh. p. 38; LTKN, Vid. Meddel. Naturh. For. Kbhvn 1876, p. 27; MALM, *Gbgs, Boh. Fn.*, p. 406; WINTH., *Zool. Dan., Fiske*, p. 10, tab. II, fig. 6; ID., Naturh. Tidskr. Kbhvn, ser. 3, vol. XII, p. 11; DAY, *Fish. G:t Brit., Irel.*, vol. I, p. 67, tab. XXVIII, fig. 1; LILLJ., *Sv., Norg. Fisk.*, vol. I, p. 187; MÖB., HCKE, *Fisch. Osts.*, p. 51.

Aspidophorus armatus, LACÉP., *Hist. Nat. Poiss.*, tom. III, p. 222.

Aspidophorus europæus, CUV., VAL., *Hist. Nat. Poiss.*, vol. IV, p. 201.

The Bearded Cottus attains about the same length as the preceding species, but the form of the body is both deeper and broader. The anterior part of the body is so strongly depressed that the breadth, measured across the insertion of the pectoral fins is 125 % of the depth[g], which, at the same point, is somewhat less than $^1/_7$ of the length of the body. The dorsal line, which is highest at the occiput, slopes almost in a straight line from this point to the caudal fin. The ventral line is almost straight. The head is depressed, broader than the body, angularly rounded at the top and flat underneath; and in length measures somewhat more than $^1/_5$ of the length of the body. The breadth of the head across the gill-cover is about equal to its length. The forehead is flat and slopes evenly towards the snout, which is divided at the point, projects far in front of the mouth and, at the extreme point, is furnished with four spines or horns, the two anterior pointing forwards and the two posterior curved backwards. In some specimens one or more of these spines are branched at the tip. The gape is small, semicircular or crescent-shaped, is situated on the lower side of the head, and is not directed upwards. The corner of the mouth ends below the anterior margin of the orbit. The jaws are armed with extremely fine, conical and straight teeth, with the points somewhat recurved, and set in several irregular rows, thus forming fairly broad bands (cards). The two upper pharyngeal cards are round, the two lower triangular, all four being composed of very small teeth. The gill-openings of average size. The preoperculum, the surface of which is generally striated, is almost twice as high as broad (long), and at the lower posterior corner is furnished with a spine, pointing in a backward direction and generally recurved. The operculum is also striated in most cases, is of small size and irregular, triangular form, with its longest corner pointing downwards, and bears superiorly a blunt, longitudinal ridge. The nostrils are arranged as in the preceding species, and here too, the posterior one on each side is so small that it is to be distinguished only with difficulty. The eyes, which are set high, are smaller than in the preceding species, the diameter being less than the least breadth of the interorbital space. The distance between them and the tip of the snout is less than that between them and the gill-openings. We sometimes find round the iris a ring of dermal tubercles, especially well-developed and raised in a conical shape on the lower part of its margin. The superior margin of the orbit forms a raised, blunt ridge, which is sharper and even furnished with spines during youth. From this ridge run two bars, diverging posteriorly, the inner of which ends in a protuberance corresponding to the ordinary occipital spine of the *Cotti*, while the outer runs across the squamosal bone and ends in an obtuse spine, at the hind point of the posttemporal bone. The suborbital bones are elongated; the lower part of the anterior one is furnished with three transverse ridges, with depressions between them which contain the muciferous cavities and pores belonging to the system of the lateral line; and the posterior, which is larger and is united to the preoperculum, is square in form and has a bony spine, pointing in a backward direction, at the middle of the raised lower margin. The spines of the head are thus 8 in number — four on the tip of the snout and two on each side of the head, the anterior on the suborbital bone and the posterior on the preoperculum. On the head we also find a number of short barbels, which are characteristic of this species, and the arrangement of which is given in the specific description.

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[a] From 31 to 33 in the specimens of the Royal Museum.

[b] At least 32·2 % in the specimens of the Royal Museum.

[c] Sometimes 5, according to LÜTKEN.

[d] „ 15, „ „ „

[e] All the rays simple, 3 or 4 supporting rays above, and 2 or 3 below the 7 middle rays.

[f] According to LILLJEBORG. In the specimens of the Royal Museum we have found 35 in one young specimen and from 37 to 39 in older specimens.

[g] In the preceding species (see the table) we have found the greatest depth of the body to be from 84 to 89 % of the greatest breadth; in this species, on the other hand, this ratio varies between 67 and 74 %.

The body is covered with plate-like scales, furnished with an edge or compressed elevation, which in most cases, at least among young specimens, ends in a more or less sharp point, which extends back over the margin of the next scale. These plates are set in regular rows, which form longitudinal ridges or edges. The back and a part of the sides are covered by two rows, the plates of which, especially the anterior by the occiput, are larger than those of the other rows, and the anterior ones, especially in old specimens, without any spine. These two rows, each of which is made up of about 20 plates — four of which lie in front of the first dorsal fin, two, one or none between the two dorsal fins, and seven or eight along the base of the second dorsal fin — form a furrow along the back, are broad anteriorly, and gradually decrease in breadth towards the second dorsal fin, at the end of which, when it is depressed, they unite and from this point to the base of the caudal fin form only one row, containing about 12 plates[a]. Under the belly there are two rows, with about 20 plates in each, and in extent and position analogous to those on the back. They unite at the end of the anal fin, forming from this point to the root of the caudal fin a simple row of 12 plates. This union of the rows of plates, both on the back and on the belly, renders the anterior part of the body octagonal, the posterior hexagonal. Between the rows described there are two others, parallel to them, on each side of the body; the upper consists of about 27 plates, begins at the end of the pectoral fin, and extends in a straight line from this point to the base of the caudal fin; the lower begins at the insertion of the pectoral fin, consists of about 34 plates, and also ends at the base of the caudal fin. Besides these regular rows of plates, there are other smaller, convex, rounded plates, on some parts of the body, e. g. in front of the pectoral fins and round the vent. The lateral line, the scales of which, like the plates, gradually diminish in size as they approach the caudal fin, runs along the middle of the body, rises slightly above the pectoral fins, and from the end of these fins runs in a straight line to the caudal fin. The vent lies well in front, at the end of the first quarter of the length of the body.

The first dorsal fin is almost triangular, with rounded apex, and contains five or six simple rays, the tips of which do not project above the fin-membrane; the first ray is slightly shorter than the second, which is the longest. The second dorsal fin, which begins fairly close to, or even just at the end of the first, above the beginning of the anal fin, is of almost uniform height, and contains six or seven (sometimes eight) simple rays, the first of which is shorter than the next three, which are of equal length and the longest of all the rays, but still are overtopped by the fin-membrane. The pectoral fins, which are inserted close to the gill-openings, are large, rounded at the point and with from 15 to 17 (generally 16) simple rays. The ventral fins are situated a little behind the insertion of the pectoral, and contain three rays, the first of which is a spinous ray closely united to the second, which, like the third, is simple and has a soft tip, extending beyond the fin-membrane. The innermost (third) ray is the longest, and may occupy as much as $^3/_5$ of the distance from the insertion of the ventral fins to the beginning of the anal fin. The latter begins below the beginning of the second dorsal fin and ends in front of the perpendicular drawn from the end of that fin. It contains from 5 to 7 simple rays. The caudal fin is long, rounded at the point and contains only simple rays, the number of which, including the supporting rays, varies between 12 and 15.

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[a] The number varies between 9 and 13; on the anterior ones the top of the ridge is longitudinally divided.

The upper part of the body is grayish brown. Back and sides marked, as in the *Cotti*, with four, large, nearly black spots or rather transverse bands, the first of which is situated at the hind part of the first dorsal fin, the second at the hind part of the second dorsal fin, the third at the middle of the peduncle of the tail, and the fourth at the base of the caudal fin. Lower side of the head and the belly white or whitish yellow, generally unbroken to the end of the anal fin, behind which point some more or less distinct, grayish brown spots are always to be found. Dorsal and pectoral fins, like the caudal, light gray, with irregular, dark spots and transverse bands. Barbels and anal fin white, as well as the ventral fins, which are sometimes marked, however, with dark spots. Iris bronze, with red streaks radiating from the pupil, which is green.

Liver small and forming two lobes, one of them very small and the other comparatively large and rounded at the point. Œsophagus very short; stomach also short, but broad. Five short and thick pyloric appendages. The intestinal canal forms two bends. The abdominal cavity occupies about a quarter of the length of the body, and the vent lies almost at its middle. Ovaries large, extending along nearly the whole length of the abdominal cavity. Kidneys equal in length to the abdominal cavity, and set, as usual, under the sides of the spinal column. No trace of an air-bladder.

NILSSON states, as an external sexual difference, that in this species, as in most of the *Cotti*, the male is distinguished from the female by a soft papilla behind the vent, and that the interorbital space is apparently broader in the male, measuring about half as much again as the diameter of the eye and being almost flat. The males, however, are so rare that neither KRØYER or EKSTRÖM has met with an example, full-grown at least, nor during late years has the Royal Museum received a single male specimen.

The geographical range of the Bearded Cottus, or as it is commonly called, the Armed Bullhead in the north-east of the basin of the Atlantic is fairly wide, extending from the White Sea and Iceland at least as far as the English Channel; but it seems nowhere to be one of the common species. As early as 1830 the Royal Museum received from Mr. BULL a specimen from Hammerfest. In the Baltic the Armed Bullhead is rare even off Kiel, according to MÖBIUS and HEINCKE, but occurs, according to NILSSON, on the south coast of Scania, and, according to MELA[a], has strayed as far as the Gulf of Finland.

The Armed Bullhead prefers to make its home on a sandy and weedy bottom. During the summer months, from April to November, the females are met with in water of a moderate depth, but at the approach of winter they withdraw into deep water. The males, as we have already mentioned, are extremely rare, probably because it is only during the spawning-season that they live in so shallow water as to be in any danger from the nets used in shore-fishing.

In its habits, as in its appearance, the Armed Bullhead closely resembles the *Cotti*. It hardly ever leaves the bottom, where it seeks its food, which consists chiefly of small crustaceans. The spawning-season is in spring, in March[b] and April or the beginning of May. We have no information as to the way in which the roe is deposited or the development of the fry.

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[a] *Vertebrata Fennica*, tab. IX.

[b] Cf. MALM and DAY, ll. cc.

The fecundity of this species is apparently not great. KROYER assumes the number of eggs in a full-grown female at about 3,000, a number which is insignificant compared with that in most other fishes. According to the same author the fry have reached by September a length of about 90 or 100 mm.; but the Royal Museum possesses a specimen 32 mm. long, which was taken at a depth of 16 or 17 fathoms on Stora Middelgrund in the Cattegat, on the 10th of July, and another, 50 mm. long, which was caught in Strömstad Fjord in December. EKSTRÖM also remarks that the specimens he obtained in spring on the coast of Bohuslän were seldom more than from 80 to 100 mm. long, and he therefore assumes that Armed Bullheads of this size are a year old.

The Armed Bullhead is occasionally caught in Herring-nets or Eel-pots; but as it is not used as food, or even as bait for larger fishes, there is no special fishery for it. Its flesh, however, is white, firm and of good flavour. Its singular appearance has conferred upon it several Swedish names. Its usual name in Bohuslän is *Bottenmus* (Bottom-mouse), corresponding to the Danish *Harmus*. At Kullen, according to NILSSON, it is called *Kuderusk* and at Abekås (southern Scania) *Hornuggla* (Horned-owl).

(EKSTRÖM, SMITT.)

BLENNOMORPHI.

Body elongated, low and laterally compressed. Dorsal and anal fins long, usually with simple rays, the majority of which, on the back, are generally hard and spinous. Ventral fins (when present) jugular or thoracic, free from each other, but often with a reduced number of rays. Pectoral fins generally with broad basal bones, and the caudal fin with only few branched rays. Suborbital ring generally without the osseous connexion with the preoperculum. Anal papilla sometimes present. Scales generally weak and small, imbedded in the slimy skin; or even wanting.

Around the old genus *Blennius* of ARTEDI, GÜNTHER[a] has collected this series of families, the common characters of which appear chiefly in the more or less ribbon-shaped body and the numerous spinous rays, generally of uniform strength, in the long dorsal fin, which is most often continuous, but may also be broken up into two or three fins, the two anterior ones, in the latter case, being spinous-rayed. This series, however, shows traces of forms of transition both to the Labromorphs and to the Malacopterygian Physoclysts. Even in some Scandinavian forms, e. g. the genus *Anarrhichas*, we find traces of a transition in the latter direction, most of the rays in the dorsal fin being soft (but unarticulated), and only the hindmost part of the fin retaining a number of spinous rays. In the genus *Enchelyopus* (*Zoarces*) too, the spinous rays are confined to the posterior part of the dorsal fin, and this analogy to *Anarrhichas* might well justify the retention of *Enchelyopus* within this series. But the structure of the soft dorsal rays, as entirely different from that in *Anarrhichas*, and the diphycercal form of the tail, one of the points most characteristic of the lowest (and earliest) stages of development, and among the Physoclysts most often retained by the *Anacanthini*, are still more powerful advocates of Gill's procedure in referring the genus to these last fishes.

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[a] *Syst. Syn. Fam. Acanthopt. Fish.*, Cat. Brit. Mus., Fish., and in *Introd. Study of Fish.*, p. 490 (*Handb. Ichth.* p. 348). GILL has a corresponding "Super-family", *Blennoidea*, from which he has, however, excluded the families which by their various irregularities throw difficulties in the way of the limitation of the series by fixed characters. The families *Cepolidæ* and *Trichonotidæ* are referred by GILL to his *Physoclysti incertæ sedis*. The *Heterolepidotidæ* (*Chiridæ*) he refers to the Cottomorph series — we have above remarked the Idiopterous appearance of these fishes; and even if the osseous connexion which they possess between the suborbital ring and the preoperculum, seems scarcely enough to justify their inclusion among the *Cottomorphi*, still their place in GILL's system, close to the *Labromorphi*, is perhaps a more suitable one. For the family *Mastacembelidæ*, on the other hand, which GÜNTHER, in spite of the fact that it is separated from the rest of the Physoclysts by the absence of any connexion between the shoulder-girdle and the skull, has referred to the Blennomorph series, GILL, following COPE (Trans. Amer. Philos. Soc., Philad., n. ser. vol. XIV, p. 456), has retained a special suborder, *Opisthomi*, which he has placed nearest to the Eels. For the genus *Enchelyopus* too, GILL has formed a distinct subfamily within the family *Lycodidæ* (Smith's Misc. Coll. No. 283, p. 7), a place undoubtedly more natural for this genus. See Proc. Acad. Nat Sc. Philad., 1863, p. 255.

Cuvier[a] united these fishes with the following series into one family, *Gobioïdes*[b], of which Bonaparte[c] regarded them as a subfamily, *Blenniini*, which was set apart by Müller[d] as a distinct family, *Blennioidei*. Since that time so many forms have been discovered that it has become necessary to distribute them among several families, of which the Scandinavian fauna includes two.

Fam. **BLENNIIDÆ.**

External bones of the head unarmed. No osseous connexion between the suborbital ring and the preoperculum. Jaw-teeth (like the palatine teeth, where they exist) of ordinary shape, conical or curved, of uniform size or interspersed with canines. Scales of the body generally small with smooth margins, and imbedded in the slimy skin; or even wanting. One, two or three dorsal fins extend along the whole length of the back behind the occiput, or at least the greater part thereof. Anal fin also long. Ventral fins generally jugular, with reduced number of rays; in some genera wanting. Pseudobranchiæ generally distinct. Air-bladder and pyloric appendages generally wanting.

The Greek *βλέννος* (*slimy* or *silly*) was a small Mediterranean fish that lived among the seaweed; but its species can scarcely be fixed at the present time, as the old writers have given no description of it. It was, however, the Butterfly Blenny (*Blennus* in Belon and Gesner, *Blennius ocellaris* in Linnæus), a species common in the Mediterranean, that Artedi chose as the type for the genus *Blennius*, which was the first genus among his Acanthopterygians, and which he defined with about the same characters as are now applied to the Blennomorph series. Most of these fishes belong to the Blennioid family, which, even within the limits given above, offers considerable variety of form. About 250 species, distributed among from 30 to 40 genera, have been described. The majority of the Blennioids and their most typical representatives are small shore-fishes, common in the tropic and temperate seas, and some of them extraordinarily small. They are generally of sluggish temperament, but momentarily their movements are extremely quick. At their homes on rocky shores, where they are left dry by the retiring tide, these fishes, so tenacious of life are they, lead an almost amphibious life. An East-Indian species, *Salarias tridactylus*, has indeed been called *amphibius;* and Commerson, Forster and Ehrenberg[e], all three have watched with interest and described its swift, leaping motions even on dry land, where it is said to hunt insects. During their life on land and also at the bottom of the sea, the ventral fins in particular, and the pectoral as well, are said to serve as admirable organs of motion. The eyes too, the brilliancy of which reminds us of those of the snakes, continue to perform their functions out of the water[f]. The family is not destitute, either, of the beauty of bright and varying colours; many of the Blennioids are, in splendour of colour, the rivals of the Wrasses, while the form of the body sometimes calls to mind the *Julidinæ*, a likeness enhanced by the general thickness of the lips and the frequent occurrence of canine teeth in the back part of the jaws.

The genera which belong to the Scandinavian fauna, may be distinguished by the help of the appended table:

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[a] *Règne Animal*, ed. 2, tome II, p. 236.

[b] Called *Blennioidei* by Nilsson (*Skand. Fn.*, *Fiskarne*, p. 180).

[c] Isis, 1833, p. 1199.

[d] Abh. Acad. Wiss. Berlin 1844, p. 199.

[e] See Cuv., Val., *Hist. Nat. Poiss.*, XI, p. 340.

[f] Cf. Day, *Fish. Gt Brit. Irel.*, vol. I, p. 198.

I: Front jaw-teeth firmly set in one row, and sharpened at the point like a chisel (anteriorly and posteriorly compressed incisors). At least the greater part of the dorsal fin (in the Scandinavian species the whole) soft-rayed . . . Genus *Blennius*.

II: Jaw-teeth conical, sharp or blunt, generally set in several rows, and more or less far apart from each other. Only spinous rays in the dorsal fin:

  1: Branchiostegal membranes to a great extent united, and the gill-openings therefore vertical. Ventral fins small, with thick skin, or wanting:

    a: No spinous ray in the anal fin. Head above the eyes furnished with dermal fringes .... Genus *Chirolophis*.

    b: Two spinous rays at the beginning of the anal fin. No dermal fringes on the head .... Genus *Pholis*.

  2: Branchiostegal membranes only slightly united, the lower part of the gill-openings extending in a forward direction. Ventral fins with thin skin and fairly long (equal in length to the lower jaw) . . . Genus *Lumpenus*.

Genus BLENNIUS.

Body naked (without scales). In the anterior part of the jaws an arcuate row of strong, closely set, recurved and chisel-like teeth: in the back of the jaws generally solitary canines. Head short, with the upper profile sharply curved. Mouth small, gape horizontal. Gill-openings fairly large, but vertical; branchiostegal membranes with 6 rays and broadly united to each other or to the isthmus. One continuous dorsal fin, generally, however, incised at the margin, with most (or all) of its rays soft, but unarticulated, at least in the anterior part of the fin. Only the caudal fin with branched rays, and these generally few (under 10?). Ventral fins with thick skin, one short spinous ray and three soft rays. Anterior part of the lateral line arcuate, and often the only distinguishable portion thereof. Pseudobranchiæ distinct. Air-bladder and pyloric appendages wanting.

This genus includes about 40 species, which belong chiefly to the Atlantic. Some, however, have been found in the Red Sea and off Ceylon, the Sandwich Islands and Tasmania; and one species (*Blennius Sujefianus* or *Cagnota*) has domiciled itself in the fresh-water of the east of Spain, the south of France, Italy and Dalmatia. Although the naked, slimy skin is without the brightness lent by the scales to the body of other fishes, still some of these species belong to those most richly endowed with beauty of colouring. Hence some of them bear such names as *butterfly* and *peacock*. As we have mentioned above, they are shore-fishes; but some of them have been met with far out at sea, following pieces of wreckage or finding a permanent home among the floating Sargasso-weed. Only one species belongs to the Scandinavian fauna.

THE SHANNY (SW. SKYGGFISKEN[a]).

BLENNIUS PHOLIS.

Fig. 61.

Head without dermal fringes above the eyes, but the hind margin of the anterior nostrils raised and broken up into a fringe. Even the anterior part of the dorsal fin with rays soft at the tip. One or two canine teeth on each side of the upper and lower jaws, behind the end of the front row, which consists of from 15 to 24 compressed teeth.

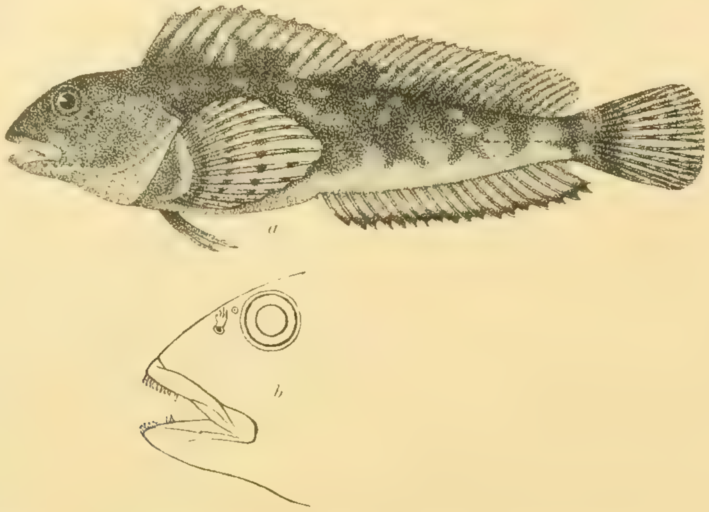

Fig. 61. Shanny (*Blennius pholis*), taken on the fishing-bank of Jæderen (on the coast of Norway), at a depth of from 60 to 100 fathoms, according to the statements of the fishermen. *a:* natural size; *b:* the head, magn. 2 diam., in order to show the position of the nostrils and the dermal flap of the anterior nostril. The lips too, are turned slightly back to show the teeth.

R. br. 6; *D.* $\frac{12^{b}}{18\text{ l. }19^{c}}$; *A.* 19[d]; *P.* 13; *V.* ${}^{1}{}_{3}$; *C.* $x+9+x$;
L. lat. por. 40—50.

Syn. Vix *Φολὶς*, ARISTOT.; vix *Pholis* RONDEL.; vide ART. *Syn.*, p. 116.

Cataphractus lævis, JAGO apud RAIUM, *Syn. Meth. Pisc.*, p. 164, tab. 1, fig. 10.

Blennius Pholis (p. p.) LIN., *Syst. Nat.*, ed. X, tom. I, p. 257; BL., *Fisch. Deutschl.*, part. II, p. 184, tab. LXXI, figg. 2 et 3; YARR., *Hist. Brit. Fish.*, ed. II, vol. I, p. 260; GTHR, *Cat. Brit. Mus.*, *Fish.*, vol. III, p. 226; STEIND., Stzber. Akad. Wiss. Wien, LVII, I, (1868), p. 674; COLL., Vid. Selsk. Forh. Crist. 1874, Tillægsh., p. 72; ibid. 1879, No. 1, p. 58; DAY, *Fish. Gt Brit.*, *Irel.*, vol. I, p. 203, tab. LX, fig. 2; MOREAU, *Hist. Nat. Poiss. Fr.*, tom. 2, p. 143.

Pholis lævis, FLEM., *Hist. Brit. Anim.*, p. 207; CUV., VAL., *Hist. Nat. Poiss.*, vol. XI, p. 269; KRØY., *Danm. Fiske*, vol. I, p. 330; NILSS., *Skand. Fn.*, *Fisk.*, p. 182; LILLJ., *Sv.*, *Norg. Fisk.*, vol. I, p. 517.

The Shanny, which attains a length of 160 mm., is in form of body relatively the deepest and thickest of the Scandinavian Blennioids, the greatest depth of the body being 19 or 20 % of the length, and the greatest breadth, across the cheeks, from 14 to 16 %. The breadth at the axils is equal to, or only slightly less than, the breadth across the cheeks, and the posterior part of the body is more compressed at the dorsal edge than at the ventral. With this exception it tapers fairly evenly towards the tail, which is strongly compressed, though the abdomen is, as usual, more swollen, even laterally. The least depth of the body in a young specimen, 93 mm. long, measured 6·8 % of the length, and in an older specimen, 125 mm. long, 7·7 %. The head, with the eyes set high and the snout steeply sloping, measures in young specimens 27 % of the length of the body, in old 26 %. The gape is fairly small, placed low down and almost horizontal, with the upper jaw projecting slightly in front of the lower, and with its swollen labial skin extending back to a point almost vertically below the middle of the eye, the longitudinal diameter of which is 18 % of the length of the head in young specimens, 16 % in old.

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[a] NILSSON, l. c.

[b] Sometimes 11, according to DAY.

[c] ,, 20, ,, ,, ,,

[d] ,, 18—20, ,, ,, ,,

Midway between the eyes, the forehead, the breadth of which is 14 % of the length of the head in young specimens and 16 % in old, is somewhat concave; and behind the eyes, on the top of the head and the occiput, we find a longitudinal dermal ridge[a], which is generally only slightly marked. The anterior nostril is situated about twice as near to the eye as to the tip of the snout, and on a level with the lower margin of the eye: its margin is only slightly raised, but grows posteriorly into from 4 to 7 dermal filaments. The posterior nostril is a little round or oblong opening, nearer the eye and about level with the upper margin of the pupil. The branchiostegal membrane extends back, in a small flap, to a point just above the upper corner of the axil; and underneath it is continuous from one side of the body to the other, but so thoroughly united to the isthmus that the breadth of the free dermal fold in the middle is only about half the diameter of the eye.

The dorsal fin is distinctly divided into an anterior part, which is short, and consists of simple and unarticulated rays, and a posterior, the rays of which are also simple, but articulated. Its length is about 61 or 62 % of that of the body, and its height from 10 to 12 % of the latter. All the rays, except the 12th from the beginning, which is the smallest, and also the last of the unarticulated rays, project, to some extent at least, above the fin-membrane, the first three or four most of all. The anterior part, which corresponds to the spinous-rayed part in other cases, is as high as, or slightly lower than, the posterior; and its length is about 78 % of that of the latter. The anal fin is lower than the posterior part of the dorsal fin (its height is about $9^{1}/_{2}$ % of the length of the body), but in length and structure it corresponds to the latter. The distance from the tip of the snout to the beginning of the anal fin is 47 or 48 % of the length of the body. In one of the males we have examined, we found at the beginning of the anal fin a vesiculate dermal swelling, united to the first ray of the fin and representing the anal papilla. The caudal fin is rounded, and its length measures 7 or 8 % of that of the body. The pectoral fins are also round: their length is less than that of the abdominal cavity, being only about $^{1}/_{5}$ of the length of the body. A little in front of these fins we find the singularly-formed ventral fins, the length of which is almost half that of the head, and about half (more or less) the distance between them and the beginning of the anal fin. The rays are gathered into two bunches, each with a separate dermal covering, which extends about half-way along the fin. The outer (anterior) bunch contains the short spinous ray, the length of which is about a third of that of the second ray, together with the latter ray, which is simple and articulated; the other bunch contains the two remaining rays, which are also simple and articulated. Each ventral fin has thus the appearance of two fingers, the inner one being the longer, owing to the circumstance that the middle soft ray is the longest in the fin.

On the naked, slimy body the lateral line at first bends slightly upwards towards the back, but soon sinks again in a curve which ends above the beginning of the anal fin: from this point it advances in a straight line almost along the middle of the sides of the tail. It contains about 45 pores, the hindmost of which are, however, not very distinct. Rows of small pores beneath the eyes and out on the snout, as well as at the bottom of the cheeks and forward on the lower side of the under-jaw, mark the extension of the system of the lateral line on the head.

The colouring of the Shanny is so variable that one can scarcely find two individuals exactly alike in this respect. The colours are most diversified and brightest in young specimens, one of which is thus described by LILLJEBORG. "Upper part of the body dark green, marbled with a somewhat darker tint and with yellowish spots along the upper and lower parts of the sides. Dorsal and pectoral fins with dark stripes on a lighter, greenish ground. Caudal fin with broad, yellowish and dark greenish transverse bands. The anal fin, the rays of which are tipped with white, is next marked with a blackish, longitudinal stripe, and yellowish at the base. Ventral side and fins yellowish. Lower side of the head yellowish, clouded with darker colour." In a specimen 93 mm. in length, which has been preserved in spirits for ten years or so, we still find distinct traces of five large spots, edged with white, which in live specimens extend half-way up the dorsal fin, the upper part of which is marked with a network of smaller quadrilateral spots. Below the lateral line we also find large dark spots, divided at the bottom. The anal fin still retains its dark marginal band, with the light tips of the rays. In older specimens there is a more irregular arrangement of dark brown spots on the dark greenish body. The colours are also duller during winter.

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[a] Presumably a sexual distinction, peculiar to the males. "Der Nacken bei Männchen sehr fleischig." STEINDACHNER.

The Shanny prefers to live above low-water mark, and seems, like other members of the genus, to find pleasure in being left dry at ebb-tide. It then creeps about, or hides under stones or in crevices of the rocks, putting out its head and keeping a watchful eye for the approach of any danger, whereupon it hurriedly disappears. Day gives an observation made by Ross, according to which the Shanny can turn its head, while resting in its usual position, on the ventral and pectoral fins; and Couch[a] who has given the minutest details as to the habits of this fish, says that, like the chameleon, it has the power of turning its eyes in different directions, and thus seeing what is behind and before it at the same time. Even in the water it is of timid habits, and not without reason, for it is keenly pursued by waterfowl, especially cormorants, whose narrow beak, with its bent tip, seems especially adapted to drag the Shanny from its retreat. Couch kept a specimen in captivity for six months. The fish would often change colour, without any visible cause. In the aquarium lay a stone which projected out of the water, and in warm weather the fish crept up on the stone to bask in the sun. During the summer it passed half its time in this way, high and dry; but in cold weather it sank down into the water and hid itself. Ross positively asserted that, even in captivity, these migrations between dry land and water coincided with the ebb and flow of the tide; but Couch is equally positive in his denial of this circumstance.

When the tide rises, according to Couch, the Shanny goes in quest of food. It lives on all kinds of small creatures belonging to the classes of worms, mollusks or crustaceans. It seems to be especially fond of small shell-fish and Balanids which are attached to the rocks. Its bite is powerful, owing to its sharp incisor teeth. It is highly impatient of any trespass by a comrade upon its hunting-ground, and speedily attacks the trespasser. On account of its pugnacity children amuse themselves by pitting two Shannies against each other and watching them fight. The combatants long refuse to relinquish their hold in their struggles. The Shanny also retains its gripe fiercely, if it has seized a person's finger; but its teeth are not strong enough to pierce the skin. With this vindictive temper the Shanny leads a solitary life, and does not wander far, unfitted as it is for long journies by its heavy body, the front part of which is somewhat unwieldy, and by the absence of the air-bladder.

The Shanny deposits its eggs in spring or during summer, and, according to Couch, the female displays a high degree of discrimination in her choice of a nest. She selects a small hole with a narrow entrance, just above low-water mark, and attaches her bright, amber eggs, which are $2^1/_2$ mm. in diameter, to the roof of the hole, which is thus adorned with mosaic. The breeding of the Shanny, as it took place in the Manchester Aquarium, is thus described by Saville-Kent[b]: "In a tank containing some forty or fifty examples of this Blenny, a pair had selected a narrow ledge, high up on one side, for the purpose of a nursery. The eggs were deposited in a single layer upon the ledge, first by one and subsequently by a second female, the species being thus shown to be polygamous. The male had meanwhile undergone a wonderful colour transformation, much after the manner of the male of the Black Bream (*Cantharus lineatus*), previously described. All the gay mottlings of yellow and brown that usually characterise the species, had given way to a uniform tint of deep sooty black, the large, prominent lips alone remaining nearly white, his appearance under such circumstances being particularly ferocious and forbidding. Thus attired he now mounted guard over the female fish and eggs, his self-appointed task, as presently seen, proving no sinecure. The discovery was soon made, in fact, by the other members of the community, that Blennies' eggs were a choice gastronomic delicacy, and thenceforward our little friend was scarcely allowed an interval of peace. While one fish was being repulsed in front, another descended upon and made off with the coveted booty in the rear; or, as frequently happened, there was a concerted attack along his lines of more than half a dozen fish. Thus overpowered by numbers, there was but little chance of a young family descending from the rocky fortress, and, indeed, several times within the course of an entire month spent by the little Blenny in the arduous endeavour to guard his embryo brood, the little aerie was mercilessly stripped of every egg. At the end of that period an untimely end befel our little hero; wearied out with his exertion he was at length unable to cope with the odds arrayed against him, and was found one morning literally torn to pieces at the foot of the ledge he had so long defended, a huge fellow, nearly twice his size, and who had doubtless been chiefly instrumental in bringing about his overthrow, now occupying the post of honour. One other little episode concerning the object of this notice remains to be chronicled. While the female was depositing her spawn, an operation which extended over several days, her brave little partner was seen on several occasions to descend to the bottom of the tank, and hurriedly snatching up a fragment of the food supplied for the general meal, to return with it aloft and place it at the disposal of his ladylove."

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[a] *Hist. Fish. Brit. Isl.*, vol. II. p. 220.

[b] *Brit. Mar., Freshw. Fish.*, Handb. Gt. Intern. Fish. Exhib., London 1883.

Except as bait, this fish can be of no economical value to man.

The Shanny is by no means rare on the south-west coast of Norway, at least in the neighbourhood of Bergen, where REINHARDT (Maanedskr. f. Litter., 1833, p. 231) made the observations on which he based the first statement as to its geographical extension northwards; but in Sweden it has never been observed. Its true home is on the coasts of Great Britain and Ireland, extending southwards at least as far as Gibraltar (STEINDACHNER) and into the Mediterranean at least as far as Barcelona (STEINDACHNER). In the Mediterranean, however, it is not so common as in the Atlantic (VALENCIENNES), and its occurrence east of Spain has been denied (MOREAU, l. c. and GIGLIOLI, *Espoz. intern. di Pesca in Berlino 1880, Cat. Sez. Ital.*, p. 91).

GENUS **CHIROLOPHIS.**

Hind part of the body ribbon-shaped and covered with very small scales. Head naked (without scales), but with dermal fringes on the top. Jaws furnished, almost throughout their margin, with an arcuate, unbroken row of conical teeth, somewhat compressed and pointed at the apex (partly, however, especially in the front part of the jaws, alternating, every other tooth being set farther in than the next to it): no canines at the ends of the rows. Head, especially the snout, short; mouth broad, obliquely ascending. Gill-openings large, but vertical; branchiostegal membranes joined to each other under the isthmus, to which they are united. One continuous dorsal fin, containing only spinous rays, along the whole of the back behind the head. Anal fin long and with a small spinous ray at the beginning; the rest of the rays articulated and branched. Ventral fins short, jugular and containing one spinous and three branched rays. Rays of the pectoral fins repeatedly branched. Branched rays of the caudal fin few (under 14). Only the anterior part of the lateral line distinct. Branchiostegal rays 6[a]. *Pseudobranchiæ present. Air-bladder wanting. Pyloric appendages present, but small*[b].

Of this genus only one species is known with any certainty[c], and even this has borne six different generic names. The best and fullest descriptions of it have been given by KRØYER, who gave it the name of *Carelophus*[d], and NILSSON, by whom it was called *Blenniops*[e]; but both these writers were anticipated by SWAINSON, who established the genus *Chirolophis*[f].

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[a] Sometimes 5, according to NILSSON and COUCH.

[b] According to KROYER and NILSSON.

[c] PALLAS'S (*Zoogr. Ross. As.*, III, p. 179) *Blennius polyactocephalus* from Kamchatka probably belongs to this genus (cf. JORD., GILB., Bull. U. S. Nat. Mus., No. 16, p. 765), and is possibly even the same species as *Chirolophis galerita;* but it is described from a dried specimen and not further known.

[d] Naturh. Tidskr., Kbhvn, 2:den Rækkes 1:ste Bind (1844—1845), pp. 227 and 236: *Κάρη*, *head*, and *λόφος*, *crest*.

[e] *Skand. Fn., Fisk.*, p. 185 (1855).

[f] *Nat. Hist., Class. Fish., Amph., Rept.*, (Lardn. Cab. Encycl.) vol. II, p. 275. (1839): *Χείρ*, *hand*.

THE CRESTED BLENNY (SW. TÅNGSNÄRTAN).

CHIROLOPHIS GALERITA.

Plate XI, figs. 2 and 3.

Two pairs of fimbriated dermal appendages above the eyes, the posterior pair being the longer; one simple dermal flap on each side of the snout, outside the anterior nostril, and several of varying size sparsely set in several (3 or 5) rows on the top of the head and the occiput. Length of the head from 15 to 18 % of that of the body. Greatest depth of the body in old specimens somewhat greater than the length of the head, in young equal to the latter. Breadth across the cheeks about $^2/_3$ of the length of the head. Least depth of the body (in front of the base of the caudal fin) in old specimens equal to the longitudinal diameter of the orbit, which is about $^1/_5$ of the length of the head and a little less than the length of the snout. Eyes set high, close to the forehead. Number of teeth in each jaw from 80 to 100. A dermal flap, like that of the operculum, above the insertion of the pectoral fin, at the hind margin of the gill-opening; and at the same point, just above the upper part of the insertion of the pectoral fins, a bony ridge, covered with skin, curved outwards, and starting from the anterior margin of the clavicular bone. Distance between the dorsal fin and the tip of the snout somewhat less than the length of the head; the base of this fin about 70 % of the length of the body: the anterior rays sometimes (most often in the males and old specimens) elongated and furnished with dermal appendages, the rest of the fin fairly straight, with a height equal to about 7 % of the length of the body, back to about the 12th ray from the end, from which point the length of the rays gradually diminishes. Distance between the anal fin and the tip of the snout about 42 % of the length of the body; its base about $^1/_2$ the length of the body; the rays slightly shorter, but freer at the point, than those of the dorsal fin. Pectoral fins rounded, in length about 14 % of the length of the body or 76 % of that of the head. Ventral fins, even externally, divided into four parts; the third ray longest, being a little less than $^1/_4$ of the distance between these fins and the beginning of the anal fin or than $^1/_3$ of the greatest depth of the body, or somewhat more than $^1/_2$ of the length of the caudal fin, which is rounded. Coloration in young specimens yellowish brown, with dark, olive-brown, transverse bands on the sides and spots of similar colour on the dorsal fin and along its base; also with a dark ring round the eye, from which there runs a stripe to the corner of the mouth: in old specimens plain yellow or reddish brown, with irregular, dark spots at the hind part of the dorsal fin. Sometimes[a] a row of lighter, round spots along the dorsal sides or the middle of the body.

$R.\ br.\ 6\,(5);\ D.\ 50^{b};\ A.\ \frac{1}{35}^{c};\ P.\ 14;\ V.\ \frac{1}{3};\ C.\ x + 12^{d} + x.$

Syn. *Blennius crista capitis transversa, cutacea* (cit. ART.), STROEM, *Söndm. Beskr.*, vol. I, p. 322.

Blennius Galerita, LIN. (p. p. nec RONDEL., nec ART.), *Syst. Nat.*, ed. XII, tom. I, p. 441; ASCANIUS, *Ic. Rer. Nat.*, cah. 2, p. 8, tab. XIX; NILSS., *Prodr. Ichth. Scand.*, p. 102; ID. (*Blenniops*) *Skand. Fn.*, *Fisk.*, p. 185.

Blennius Ascanii, WALB., *Ichth. Art.*, part. III, p. 173, REINH., Maanedskr. f. Litter., 1833, p. 259; GTHR (*Blenniops*), *Brit. Mus. Cat.*, *Fish.*, vol. III, p. 284; MGRN (*Carelophus*), Öfvers. Vet.-Akad. Förh. 1867, p. 261; ESM., Forh. Skand. Naturf. M. Chnia, 1868, p. 523; COLL., Forh. Vid. Selsk. Chnia, 1874, Tillægsh., p. 76; MALM (*Blenniops*), *Gbgs, Boh. Fn.*, p. 471, tab. 8, fig. 2; HANSSON (*Carelophus*), Öfvers. Vet.-Akad. Förh. 1880, No. 4, p. 21; DAY, *Fish. G:t Brit., Irel.*, vol. I, p. 206, tab. LX, fig. 3; COLL., N. Mag. Naturv. Chrnia, Bd. 29 (1884) p. 68; LILLJ., *Sv., Norg. Fisk.*, vol. I, p. 491; PETERSEN, Vid. Meddel. Naturh. For. Kbhvn 1884, p. 156; GTHR (*Blenniops*), *Rep. Deep-sea Fish.*, Chall. Exp. (vol. XXII), p. 71.

Centronotus Brosme, BL., *Syst. Ichth.*, ed. SCHN., p. 167; REINH., l. c.

Blennius palmicornis, YARR., *Brit. Fish.*, ed. 1, vol. I, p. 233 (nec CUV.); *Bl. Yarrellii*, CUV., VAL., (emend.), *Hist. Nat. Poiss.*, vol. XI, p. 218; SWAINS. (*Chirolophis*), *Class. Fish. etc.*, l. c.; KRØY., Naturh. Tidskr. Kbhvn, ser. 1, vol. I, p. 372; YARR., *Brit. Fish.*, ed. 2, vol. I, p. 263; COUCH, *Fish. Brit. Isl.*, vol. II, p. 233.

Gunnellus Stroemii, CUV., VAL., l. c., p. 444; KRØY. (*Carelophus*), Naturh. Tidskr., Kbhvn, ser. 2, vol. I, pp. 227 et 236; ID., *Danm. Fiske*, vol. 1, p. 600;

Obs. The rule in accordance with which the preceding species has been generally suffered to retain the Linnæan specific name of

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[a] According to NILSSON, COUCH and COLLETT.

[b] 51—53, according to NILSSON.

[c] $\frac{1}{39-40}$, " " "

[d] 13 according to NILSSON and LILLJEBORG. In the specimen described by HANSSON 3 + 12 + 1.

pholis, here also, as Nilsson has remarked, demands the retention of the Linnæan name. *Pholis* was a Mediterranean fish, and in Rondelet (Artedi's and Linnæus's, as well as Willughby's, chief authority with regard to this species), certainly did not mean the more Atlantic species which occurs in Scandinavia, and which now bears the name. But Linnæus also quoted Gronovius's *Mus. Ichth.*, vol. II, no. 175, a passage which leaves no room for any doubt as to his application of *Blennius pholis*. Here too, where Linnæus has quoted Stroem, the case is the same; and with regard to *galerita* we now have the further advantage that hardly anyone at the present day will refer the species here in question to the same genus as the species with which it has been confounded by Linnæus. There is thus no danger of confusion, even if we retain the Linnæan specific name in both genera, in *Blennius* from the 10th and in *Chirolophis* from the 12th edition of *Systema Naturæ*.

The form of body of the Crested Blenny is, so to speak, on the point of transition to the ribbon shape; it is fairly thick anteriorly, but the caudal part, which is the longer, is perfectly ribbon-shaped. Among the characters given above we find a peculiarity, of which there is only a slight trace in *Blennius pholis*, but which is all the more developed in other forms within the family. This consists in the circumstance that on the posterior margin of the gill-opening we find, in the first place, at the top, by the upper corner, a dermal flap — evidently a continuation of the branchiostegal membrane, which here advances above the slit, and in other species, e. g. *Clinus superciliosus*[a], is continued down to the base of the pectoral fin, where, in *Blennius ocellaris* for example, it projects in a dermal flap over the upper corner of the axil — and in the second place, farther downwards and inwards, on a level with the upper half of the base of the pectoral fin, a bony ridge, covered with skin, and here of uniform height, but in *Clinus superciliosus* at the lower end produced into a hook. The upper supporting rays of the caudal fin (in the specimens belonging to the Royal Museum) are remarkable for the circumstance that the two anterior ones are real spinous rays, with a membrane between them, as well as in continuation with the dorsal fin. The membrane of the anal fin also advances over the margin of the caudal fin. Of the lateral line of the body we can only find a row of 6 pores at the beginning, but the head is furnished with the ordinary rows of distinct pores, both in the margin of the preoperculum, with a continuation under the lower jaw, and in the suborbital ring with a continuation on the snout.

The Crested Blenny is a northern form, which, at depths varying from some few to 180 fathoms, extends from the extreme north of Norway to the south coasts of Great Britain and Ireland. As early as 1762, Ström described it as occurring in the south of Norway. During Gaimard's expedition Krøyer obtained specimens at Bosekop in Finmark. In Christiania Fjord, according to Collett, it is taken almost yearly; but on the coast of Sweden it is extremely rare. In July, 1861, Malm took three small specimens, the smallest somewhat under 27 mm., the largest 34 mm. in length, at the entrance of Gullmar Fjord; and C. A. Hansson has procured for the Royal Museum a specimen 21 cm. long, a male, which was taken in December, 1879, in an oyster-dredge, at a depth of 12 fathoms, in Dynekil near Strömstad. Day gives several instances of its occurrence on the coasts of Great Britain and Ireland. Farther south it has not been found.

The habits of the Crested Blenny are but little known. According to Couch, it is now and then taken in crab-pots, into which it is probably enticed by the bait. In its stomach have been found mollusks, worms, Hydroids, Spongiæ and seaweed. Its food thus seems to be the same as that of the true Blennies; and in captivity it lives in the same way as the Shanny, ready in a moment to hide under a stone or some similar object. When resting at the bottom of the aquarium, it curls its tail up to its head, and depresses the anal fin laterally, as if to support itself more securely. It is far too rare, and its size far too small, for it to possess any economical importance.

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[a] = *Blennius mustelaris*, *Mus. Ad. Frid.* Linnæus's two original specimens are still to be found in the Royal Museum; and they show that the character, "caput absque cristis", is due to an oversight. Linnæus's var. β may perhaps be explained by the fact that in the one specimen the membrane is torn behind the third ray in the dorsal fin. The fin-formula is: $D. \frac{3 + 34\,(31)}{8\,(7)}$: $A. \frac{2}{28\,(26)}$

GENUS PHOLIS.

Body ribbon-shaped, covered with very small scales. Head naked and without dermal fringes. Jaw-teeth pointed, in front set in several rows. Head, especially the snout, short. Mouth turned upwards. Gill-openings large, but vertical; the branchiostegal membranes united to each other under the isthmus, to which they are joined only in front. One, continuous dorsal fin, containing only spinous rays, along the whole of the back behind the head. Anal fin long, with two spinous rays at the beginning, and with the other rays articulated and (usually distinctly) branched. Ventral fins short, jugular and containing one spinous ray and one (indistinct) soft ray. All the rays of the pectoral fins often branched. Branched rays in the caudal fin few (under 15). Lateral line indistinct. Branchiostegal rays 5. Pseudobranchiæ present. Air-bladder and pyloric appendages wanting.

To receive the common Spotted Gunnel, as it was described and figured by SUJEF[a], LACÉPÈDE[b] formed the genus *Murænoides* a year before BLOCH-SCHNEIDER called the same genus *Centronotus*[c], the two names which, together with VALENCIENNES's[d] later name of *Gunnellus*, have been most generally recognised up to the present. Long before LACÉPÈDE's time, however, the same species had been adopted by GRONOVIUS, in 1763, as the type of the genus *Pholis*[e], the name which, according to the current laws of nomenclature, must thus possess the right of priority. The name is derived, however, from ARISTOTLE[f], and originally denoted a Mediterranean fish "which hides itself in its own mucus". The genus is very nearly related to the preceding one; but the still more ribbon-shaped body, the pointed jaw-teeth, set in several rows, and the structure of the ventral fins — one small, pungent, spinous ray and one rudimentary, soft ray in the membrane inside it — or even the absence of these fins, are the distinguishing characters of these fishes, of which six or seven species have hitherto been recognised from the northern parts of the Atlantic and Pacific.

THE SPOTTED GUNNEL (SW. TESTEFISKEN).

PHOLIS GUNNELLUS.

Plate XI, fig. 6.

Along the base of the dorsal fin a row of about 10 black, ocellated spots, which also extend slightly down over the back of the body. Rays in the dorsal fin at most 81.

R. br. 5; *D.* 76—81; *A.* $\frac{2}{40-42}$; *P.* 9—12; *V.* $^{1}/_{1}$; *C.* $x+13$ l. $14+x$.

Syn. *Ophidion* cirrhis carens; ART., *Gen.*, p. 25; *Syn.*, p. 42; HEYKE, Vet. Akad. Handl. 1744, p. 129; LIN., *Fn. Suec.*, ed. 1, p. 108; *Ophidium imberbe*, LIN., *Fn. Suec.*, ed. II, p. 114.

Blennius Gunellus LIN., *Mus. Ad. Frid.*, tom. I, p. 69, *Syst. Nat.* (*Bl. Gunnellus*), ed. X, tom. I, p. 257; *Fn. Suec.*, ed. II, p. 114; NILSS. (*Centronotus*), *Prodr. Ichth. Scand.*, p. 103; FRIES et WRIGHT, *Skand. Fisk.*, ed. I, p. 105, tab. 25, fig. 1; SWAINS., (*Ophisomus*), *Fish.*, etc., vol. II, p. 277; GTHR (*Centronotus*), *Cat. Brit. Mus.*, *Fish.*, vol. III, p. 285; MGRN, *Finl. Fisk.* (disp.), p. 21; GILL (*Murænoides*), Proc. Acad. Nat. Sc. Philad., 1864, p. 204; COLL. (*Centronotus*), Forh. Vid. Selsk. Chnia, 1874, Tillægsh., p. 77; N. Mag. Naturv., Bd. 29 (1884), p. 69; MALM, *Gbgs, Boh. Fn.*, p. 472; WINTH., Naturh. Tidskr. Kbhvn, ser. III, vol. XII, p. 23; DAY, *Fish. G:t Brit.*, *Irel.*, vol. I, p. 208, tab. LXI, fig. 1; MELA, *Vert. Fenn.*, p. 290, tab. IX; MÖB., HCKE, *Fisch. Osts.*, p. 61; LILLJ., *Sv.*, *Norg. Fisk.*, vol. I, p. 522; JORD., GILB. (*Murænoides*), Bull. U. S. Nat. Mus., No. 16, p. 767; HANSEN (*Centronotus*), *Zool. Dan.*, *Fiske*, p. 48, tab. VIII, fig. 1.

Gunnellus vulgaris, FLEM., *Brit. Anim.*, p. 207; CUV., VAL., *Hist. Nat. Poiss.*, vol. XI, p. 419; KR., *Danm. Fiske*, vol. I, pp. 341 et 600; NILSS., *Skand. Fn.*, *Fisk.*, p. 200; MOR., *Hist. Nat. Poiss. Fr.*, vol. II, p. 153.

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[a] Acta Petrop. 1779, part. II, p. 195, tab. VI, fig. 1.

[b] *Hist. Nat. Poiss.*, tom. II, p. 324; — 1800.

[c] *Syst. Ichth.*, BL., ed. SCHN., p. 165.

[d] CUV., VAL., *Hist. Nat. Poiss.*, vol. XI, p. 418, corresponding to CUVIER's subgenus *Les Gonnelles* (*Regn. Anim.*, ed. 2, tom. II, p. 239).

[e] *Zoophyl.*, Fasc. I, p. 78.

[f] Cf. CUV., VAL., l. c., p. 269.

On the coasts of Scandinavia the Spotted Gunnel attains a length of at least 23 cm.[a]; the depth is about $^1/_9$ of the length[b], and the thickness, which is greatest across the cheeks, is in young specimens somewhat more than, in old specimens equal to or less than $^1/_2$ the greatest depth. The body is strongly compressed laterally and elongated, being of almost uniform depth for more than half its length, and then very gradually tapering towards the tail. This form gives the fish a swordlike appearance, and hence, in various places, it bears the name of *Swordfish*. The head is small, measuring only $^1/_9$ of the length of the body, compressed, and so sharp at the top that the occiput and forehead form a rounded carina. Cheeks somewhat tumid and prominent. Mouth small, turned sharply up[c], and furnished with fairly thick lips, which are rolled over the jaw-bones; both jaws of about the same length; the lower jaw, however, projects distinctly beyond the tip of the snout, when the mouth is open. The eyes are small and set so high that a line drawn from the back point of the gill-cover to the margin of the upper jaw touches their lower margin; they are also set so far forward that the distance from the tip of the snout to the anterior margin of the eye is only $^1/_3$ of that from the posterior margin of the eye to the back point of the gill-cover; their diameter is $^1/_5$, or in old specimens $^1/_6$ of the length of the head. The length of the gill-cover exceeds $^1/_3$ of the length of the head, and its end coincides with the top of the insertion of the pectoral fins. The gill-openings are of average size. Both the branchiostegal membranes extend round the upper corner of the gill-openings above, and below they are united to each other without any visible incision. They thus lie free round the isthmus, like a collar, being united to it only in front. Branchiostegal rays 5, the four uppermost being fairly broad, but the fifth very narrow, and so short that it does not extend to the margin of the branchiostegal membrane, and is directed more towards the isthmus. Branchial arches small, the hindmost grown together with the posterior wall of the branchial cavity and leaving only a small slit open behind it. The gill-rakers appear in the form of subulate teeth, set, as usual, in two rows. The upper pharyngeals are united into two almond-shaped lumps, thickly set with fine, cardiform teeth; the lower are smaller, but their dentition similar. The tongue is smooth, hard, cartilaginous and triangular, with the tip free. In both jaws we find small, conical, fairly sharp teeth, set some distance apart from each other: in the upper jaw the largest (about 11 on each side) are set in an outer, more regular row, within which there are from 1 to 3 irregular rows of smaller teeth, generally most numerous in the front part of the jaw. In the lower jaw, on the other hand, the teeth are set in only one row, about 11 on each side and the largest in front; but within the front teeth we find a few small ones, irregularly set and varying in number. On the head of the vomer there are a few (from 3 to 6) small teeth, like the jaw-teeth, but set in an arcuate row. The palatine bones are toothless.

The skin is covered with an abundant mucous secretion, and in the living fish one can scarcely find a trace of the small, round scales, which are deeply imbedded therein, and, without touching each other, are spread over the whole body. The lateral line, however, is scarcely visible, but, in the form of a row of small pores, runs in a straight line almost along the middle of the body, slightly nearer the dorsal edge than the ventral. On the other hand, the ordinary rows of pores on the head which belong to the system of the lateral line, are very distinct.

The dorsal fin is unbroken, low and of almost uniform height: it begins above the base of the pectoral fins, and extends to the caudal fin, to the base of which its membrane is united, though the two fins are distinctly separate. All its rays, about 80 in number, are simple, hard, fairly thick at the base and very sharp at the tip. Their pungent tips are completely hidden, however, by the thick membrane, as long as the fin is intact, but if it be damaged, force their way out of the covering. The anal fin is of the same shape as the dorsal and ends vertically below the posterior end of that fin, but it is somewhat higher. The distance between it and the tip of the snout is from about 47 to 52 % of the length of the body. It has two, hard, pungent rays at the beginning, and the rest of it consists of from 40 to 42 articulated, soft rays, which are as it were divided at the point, or at least show traces of a division there. The pectoral fins are oval and very small, their length being about half the depth of the body, or, in old specimens, less. They are inserted very low, the upper end of the axil occupying the top of the lowest third of the depth of the body. They contain 11 or 12 rays[a], the first three of which may be simple; the 6th and 7th are the longest. The ventral fins are extremely small, almost rudimentary, and are set close to each other, very slightly in front of the pectoral fins. At first sight they seem to consist of only one small, hard and very sharp ray, which is very thick at the base, in length about $^{1}/_{2}$ the diameter of the eye, and enveloped in a thick fin-membrane with a somewhat widened rim; but on closer examination we find in the skin an inner, smaller, soft ray, closely joined to the outer one. The caudal fin is also very small, being of about the same length as the pectoral fins. When expanded, it acquires a handsome, rounded shape. It contains from 18 to 20 rays in all, the outer ones being extremely small, simple and articulated, the middle 13 or 14 branched at the tip.

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[a] Cf. COLLETT, N. Mag. Naturv., l. c.

[b] The greatest depth of the body varies between $9^1/_2$ (in young specimens) and 12 % of the length thereof. The least depth, at the base of the caudal fin varies between 3 and $3^1/_3$ % of the length.

[c] After death the mouth is generally more upturned than in life, as at death, in this species as in the preceding one, the dorsal muscles usually undergo so powerful contraction that the whole head is drawn somewhat upwards.

The colouring is yellowish brown, with indistinct, irregular, confluent, lighter, roundish spots, which give the body a mottled appearance. Under a magnifying-glass the skin also displays numbers of black dots, with which it is thickly besprinkled. Sides of the head pale. From the eye a black streak runs vertically downwards to the articulation of the lower jaw. The regions of the gill-cover, the branchiostegal membrane, the isthmus and the ventral and pectoral fins flame-yellow. Iris of a glossy, dark, greenish yellow, with a yellow ring round the pupil. Along the back, at a fixed distance from each other we find 10 (sometimes only 9, or even as many as 13) large, ocellated spots, which extend out on the dorsal fin-membrane. These spots are roundish, but irregular, and have a deep black centre, surrounded by a yellowish white ring. The front ones are generally the most distinct, the posterior ones often dull or obliterated, and sometimes these spots are entirely wanting[b]. In very young specimens, 31$^{1}/_{2}$ mm. long, Malm[c] describes these spots as being colourless, standing sharply out against the reddish brown colour of the body, which also extends over the vertical fins. The anal fin is of the same colour as the body, but is edged with flame-yellow and marked with indistinct, whitish spots, set in oblique rows, and thus having the appearance of transverse bands, when the fin is depressed. Caudal fin flame-yellow at the tip.

The entire digestive canal is short and forms a tube of almost uniform diameter, with a slight widening for the stomach, which is small, and without any true sac, or even any trace of pyloric appendages. It forms some less marked curves, and bends in the shape of an S before opening into the vent. The liver, which is pale liver-brown in colour, really forms only one lobe, envelops the stomach, and extends to the end of the first quarter of the abdominal cavity. On its inside, just in front of this point, we find the gall-bladder, which is small. Air-bladder wanting. Urinary bladder cylindrical, with long, tapering bottom, transparent, and filled with a clear, colourless fluid. On cutting open a gravid female, we find only one, large, cylindrical ovary, which fills nearly the whole of the abdominal cavity from the vent to the end of the liver. The ovary is then crammed with white eggs, almost as large as a pin's head, and, on account of their arrangement, hexagonal in shape, like the cells of a honeycomb. In the male at the same season, we find two long testicles of uniform breadth and yellowish white, as usual, in colour, which lie close to each other, and extend forwards to the end of the liver.

Of the remarkable points in the skeleton we shall point out only one, which has already been remarked by Valenciennes. Both the abdominal and the caudal vertebræ, with the exception of the first two or three among the former, have the transverse processes turned downwards and meeting each other, thus forming a closed ring for each vertebra. The number of the abdominal vertebræ is about 34, of the caudal about 51.

The Swedish name of the Spotted Gunnel (*Teste-*, *Tiste-* or *Tejstefisk*) varies in different districts according to the local form of the name of the black guillemot (*Grissla* or *Teste*). It has been named after this bird, as being one of the small fishes which form the chief part of the black guillemot's food. According to Nilsson it is called *Svärdfisk* (Swordfish) at Kivik, on account of its shape, and in Norway, according to

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[a] In a young specimen, however, we have found only 9.

[b] This variety is described by Olsson in Öfvers. Vet. Akad. Förh. 1867, p. 605.

[c] Vet. Akad. Handl., Bd. 7 (1867), No. 4, p. 5 and *Gbgs, Boh. Fn.*, l. c.

Ström, it bears the name of *Tangbrosme* (Seaweed-Brosmius). It occurs along the whole coast of Norway and Bohuslän, and also in the Cattegat, the Sound and the Baltic. Off Gothland, according to Lindström[a], it is fairly common. In 1856 the Royal Museum received from Baron A. Cederström a specimen 155 mm. long, which had been taken off Beatelund in the island-belt of Stockholm. In 1863 Widegren found the Spotted Gunnel in Alands Haf[b]; and according to Mela, it has also been taken on the coast of Nyland in the Gulf of Finland. Still, in the Baltic, it does not belong to the common fishes. It extends southwards as far as England and Ireland, and the northern part of the west coast of France. On the west of the Atlantic, it has been found in North America[c]; and whether it is a distinct species from *Pholis fasciatus* of Greenland and the Pacific species, *Pholis ornatus*, to which it is at least very nearly related, is a question that deserves more searching investigation.

As the Spotted Gunnel always leads a solitary life at the bottom, among stones and seaweed, and is an adept at finding a hiding-place, it is not taken very frequently. It generally lives in shallow water and thus, on coasts where there is any perceptible rise and fall of the tide, it is often left behind at low water in the pools or among the seaweed. It is on such occasions that its capture is most easy. It is also taken frequently amongst other fishes in the *seine*. It is tenacious of life to a very high degree, and can live fairly long out of the water. Its movements are extremely active, when attempt is made to catch it, but at other times slow and sinuous, at least in the daytime — at night it is said to move more briskly. It is seldom seen lying stretched at full length, but generally in more or less undulating curves, or even as it were folded round some object or in its retreat. This is the explanation of the fact that the Spotted Gunnel is often found hidden in empty mussel shells, in company with which it is fairly often drawn up from the bottom, especially during the oyster-fishery[d]. It has therefore been accused of making its way into live oysters and devouring them[e], but of this offence it is certainly quite innocent. Its food seems to consist chiefly of small crustaceans and mollusks, fragments of which have been found in its stomach.

At the end of October the ovaries of the female are full, and the milt-sacs of the male distended, thus showing that the spawning-season occurs in that month, or soon after. The young specimen mentioned above as described by Malm, however, was taken in July; and similar catches are recorded by Kroyer, who hence concludes that the spawning-season must be much later, unless, indeed, the growth of the fry is extraordinarily slow. It is not improbable that the spawning-season may last throughout the winter, and even extend into the early part of spring. A female, taken off Strömstad in November, still contained rather small eggs.

As the Spotted Gunnel is of no service to the fishermen, they have no special method of catching it.

(Fries, Smitt.)

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[a] *Gotl. Fisk.*, Gotl. Läns Hush. Sälls. Årsber. 1866, p. 15 (sep.).

[b] According to Malmgren, l. c.

[c] Jord., Gilb., l. c.

[d] Cf. Heyke, l. c.

[e] Cf. Kroyer, l. c., p. 354.

Genus LUMPENUS.

Body elongated, anteriorly terete, in the caudal part strongly compressed laterally (ribbon-shaped), and covered with very small scales. Cheeks, as a rule, and sometimes even the occiput, covered with scales: the rest of the head naked and without dermal fringes. Length of the head and snout moderate, or, in proportion to the depth of the head, fairly great. Gape only slightly turned upwards, or even horizontal. Gill-openings large, sloping distinctly forwards, the branchiostegal membranes being separate, and free to the very point of the isthmus. One continuous dorsal fin, containing only spinous rays, along the whole of the back behind the head. Anal fin long, and with one spinous ray at the beginning; the other rays articulated and (usually distinctly) branched. Ventral fins of moderate length, or, in proportion to the length of the body, fairly short, and with one spinous and three[a] *soft rays. Rays of the pectoral fins often all branched*[b] *except the top one. Branched rays of the caudal fin few (under 13?). Lateral line indistinct, situated at the middle of the sides. Branchiostegal rays 6 or 7. Pseudobranchiæ present, but sometimes indistinct. Air-bladder wanting. Pyloric appendages usually small, 2 or 3 in number.*

This genus was founded in 1835 by Reinhardt, when in his study of the Blennies of Greenland, he had to define *Blennius lumpenus* of Fabricius. The genus is an arctic one, with a circumpolar range, but with an extension in the Pacific down to California, and in the Atlantic to Cape Cod in the west and Scandinavia and Scotland in the east. Only from 5 to 7 species can be recognised as defined with more or less certainty; but for these species Gill[c] established five distinct genera, which by Collett[d], however, were with reason reduced to three, with the rank of only subgenera: *Leptoblennius,* with teeth in the jaws only; *Lumpenus,* with teeth in the jaws and on the palatine bones; and *Leptoclinus,* with teeth in the jaws, on the palatine bones and on the vomer. This division had already been proposed, though without any reference to the naming of the subgenera, by Reinhardt[e] in his study of the species belonging to Greenland; and for the Scandinavian species Nilsson[f] had proposed an analogous division of the genus, employing the name of *Lumpenus,* though essentially in the meaning later applied to *Leptoblennius,* still with the addition that this subgenus was without canine teeth. In Nilsson's writings *Leptoclinus* is called *Ctenodon,* a generic name previously employed in zoology and therefore here untenable. Collett[g], however, has remarked the worthlessness of the character derived from the presence or absence of palatine teeth[h]: and even though the canine teeth, as Fries[i] has also pointed out, are well-developed, and clearly distinct from the other jaw-teeth, in one of the Scandinavian species, still this character is only relative, as in the other species the jaw-teeth also vary in size. The changes of growth are also of great importance here, as in other genera. Collett has remarked that the palatine teeth are developed later than the jaw-teeth; and, to judge by individual variations, it seems to be true that the palatine teeth often disappear, in old specimens at least. Other, equally important changes of growth are remarked by Malmgren in his valuable account of the fishes of Spitzbergen[j]. He there shows, with regard to the two species *Lumpenus medius* and *L. Fabricii,* established by Reinhardt, how the length of the head and of the pectoral and ventral fins, as well as the depth and thickness of the body and the distance from the snout to the beginning of the anal fin, all diminish with age in proportion to the length of the body, the caudal part of which increases most during growth. It also appears from his tables of measurements that the length of the caudal fin undergoes even relative increase in proportion to the rising length of the body[a], even if this increase be inconstant and insignificant. The rays of the anal fin, according to Malmgren, undergo a change of growth which is important as an explanation of the structure of this fin in the kindred species and genera as well. "The division of the points, of which we can find no trace in the smallest specimens, begins in the last rays of the fin — those which are nearest to the caudal fin — and advances with the growth of the fish towards the beginning of the anal fin." That the lower rays of the pectoral fins are subject to a similar change, seems probable from the circumstance that in the largest specimens from Spitzbergen only the two or three lowest rays, in addition to the uppermost ray, are simple at the point. We must certainly expect to find corresponding alterations in the other species belonging to this genus, when they are better known, and therefore be cautious in our distinguishing of new species. Herein we may also find a clue to the explanation of the relations between the two species observed in Scandinavia, and regard them as representatives of different stages in the development of the genus.

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[a] *Lumpenus anguillaris* and *L. nubilus* are stated, however, to have four soft rays in the ventral fins.

[b] Sometimes even the lowest are simple.

[c] Proc. Acad. Nat. Sc. Philad. 1864, p. 209.

[d] N. Nordhavs-Expedition, Zool., Fiske, p. 63.

[e] Dske Vid. Selsk. Math. Naturv. Afh., Deel 7 (1838), p. 194.

[f] *Skandinavisk Fauna, Fiskarne,* p. 190.

[g] Norske Nordhavs-Expedition, Zool., Fiske, p. 64.

[h] It is easy to judge of the effects involved in this division of the genus, when one has to determine the species belonging to it. The Vega Expedition brought home three large specimens of *Lumpenus Fabricii* from Najtschkaj, just north-west of Behring Strait, the largest being 344 mm. in length. They have *D.* 60—65, *A.* $^{1}/_{42}$ and *V.* $^{1}/_{3}$; but two of them are entirely without palatine or vomerine teeth, and should thus, according to Gill, be referred to the genus *Leptoblennius,* while the third specimen has teeth on the anterior part of the palatine bones, and thus shows the correct determination of the others as well.

[i] Vet. Akad. Handl. 1837, p. 52.

[j] Öfvers. Vet. Akad. Förh. 1864, pp. 519—521.

THE SHARP-TAILED LUMPENUS (SW. SPETSSTJERTADE LÅNGEBARNET[b]).

LUMPENUS LAMPRETIFORMIS.

Plate XI, fig. 5.

No vomerine or palatine teeth. Length of the maxillary bones less than $^3/_{10}$ *of that of the head. Distance between the anal fin and the tip of the snout less than* $^2/_5$ *of the length of the body. Number of rays in the dorsal fin more than 67, in the anal fin more than 47. Pectoral fins evenly rounded; caudal fin sharply rounded or pointed.*

R. br. 6; *D.* 68—74; *A.* $\frac{1}{48-51}$; *P.* 15 l. 14; *V.* $^1/_3$; *C.* $x+11$ l. $12+x$.

Syn. *Tangbrosme No. 4*, Strõm, *Sondm. Beskr.*, I, p. 315; *Blennius capite lævi, radiis pinnæ dorsalis pungentibus*, Mohr, *Islands Naturhist.*, p. 85, tab. IV.

Blennius Lampretiformis, Walb., *Ichth. Art.*, part. III (*lumpretæformis*, p. 184; *lampretæformis*, p. 700; *Lampretiformis*, p. 702), tab. 3, fig. 6 (ex Mohr); Krøy. (*Clinus*), Naturh. Tidskr. Kbhvn, ser. 1, vol. I, pp. 32 et 37=*Clinus Mohrii*, p. 38; Id. (*Lumpenus*) ibid., ser. 3, vol. I, p. 287; Esm., Skand. Naturf. Möde, Christ. 1868, p. 523; Coll., Forh. Vid. Selsk. Christ. 1874, Tillægsh., p. 72; Id., *Norsk. Nordh. Exped., Zool., Fiske*, p. 71; Mela, *Vert. Fenn.*, p. 291, tab. IX; Lillj., *Sv., Norg. Fiskar*, I, p. 507; Jord., Gilb., Bull. U. S. Nat. Mus., No. 16, p. 779; Day, Proc. Zool. Soc. Lond. 1884, p. 445, tab. XLI; Petersen, Vid. Meddel. Naturh. For. Kbhvn 1884, p. 156.

Centronotus islandicus, Bl., *Syst. Ichth.*, ed. Schneid., p. 167; Cuv., Val. (*Gunellus*), *Hist. Nat. Poiss.*, vol. XI, p. 433; Gthr (*Stichæus*), *Cat. Brit. Mus., Fish.*, vol. III, p. 281; Malm (*Lumpenus*), *Gbgs, Boh. Fn.*, p. 470; Möb., Hcke (*Stichæus*), *Fische d. Osts.*, p. 60.

Blennius lumpenus (p. p.), Faber, *Fische Islands*, p. 79; Nilss. (*Centronotus*), *Prodr. Ichth. Scand.*, p. 104; Krøy. (*Blennius*), Naturh. Tidskr., ser. 1, vol. I, p. 519.

Clinus nebulosus, Fries, Vet. Akad. Handl. 1837, p. 55; Krøy. (*Lumpenus*), *Danm. Fiske*, vol. I, p. 336; Lillj., Vet. Akad. Handl. 1850, p. 333; Ekstr. (*Clinus*), Gbgs Vet., Vitt. Samh. Handl. 1850, p. 38; Malm, ibid., p. 90; Nilss. (*Lumpenus*), *Skand. Fn., Fisk.*, p. 195; Gill (*Centroblennius*), Proc. Acad. Nat. Sc. Philad., 1861, App., p. 45; Lovén, Öfvers. Vet. Akad. Förh. 1861, p. 291; Mgrn, ibid. 1864, p. 524; Brenner, Not. Sälls. Fn., Fl. Fenn. Förh. 1871—1874, p. 463.

Blennius gracilis, Stuwitz, N. Mag. Naturv., Christ. 1838, p. 406, tab. III; Reinh. (*Clinus*), Dansk. Vid. Selsk. Naturv. Math. Afh., Deel 7 (1838) p. 194; Krøy. (*Lumpenus*), Naturh. Tidskr., ser. 3, vol. I, p. 282; Gill (*Leptoblennius*), Proc. Acad. Nat. Sc. Philad. 1864, p. 210; Id., Smiths. Misc. Coll., N:o 283, p. 19.

The Sharp-tailed Lumpenus attains as great a length as 412 mm.[c]. In full-grown specimens the body is extraordinarily elongated; in specimens about 150 mm. long the greatest depth of the body is about 6·8 % of the length, and in specimens about 270 mm. long about 5·6 %. From the occiput to the vent the body, which is almost terete, is of uniform depth as well; but behind this point it becomes more and more compressed, even knife-shaped, and also gradually diminishes in depth to the base of the caudal fin, where the depth of the body is about 2 % of the length. The head is fairly short in proportion to the length of the body; but its relative length varies considerably according to age: in specimens 50 mm. long, according to Collett, the length of the head is about 18 % of that of the body; in specimens 154 mm. long it has proved to be 13·6 %; in specimens 271 mm. long 11·2 %; and in specimens 320 mm. in length, according to Collett, 9·7 %. The occiput is convex, the forehead somewhat compressed, and the superior profile of the head slightly curved, with the snout sloping more steeply. The gape is only slightly turned upwards, almost horizontal, and the snout projects slightly beyond the under-jaw. The eyes are fairly large, the longitudinal diameter being 24 or 23 % of the length of the head. There seem to be three pairs of nostrils, two of which, however, are very small, simple openings, most resembling the pores of the lateral line, the anterior pair being situated just behind the articulation knobs of the maxillary bones, and the posterior in front of the anterior upper corner of the eye on each side. Between these two openings on each side we find a fairly large, tubular papilla, which should probably be regarded as the true nostril[a]. The maxillary bones are rather short, and somewhat wider posteriorly than in front. Their length is from 22 to 28 % of that of the head. The intermaxillary bones, on the other hand, are narrow, but with fairly large nasal processes. The upper jaw, however, admits of scarcely any protrusion. The intermaxillary teeth are small and cardiform, but in the outer row there are several teeth of larger size than the others. The lower jaw-teeth are set in one row, or anteriorly in two. The palatine bones and vomer, as well as the tongue, which is rounded, are without teeth. Beneath the point of the chin a knob, which increases in size with age. The operculum and suboperculum, together with the posterior dermal flap, form a triangle, the base of which is about half the distance from the point of the flap, which fits into the upper corner of the axil, to the hind margin of the eye. The branchiostegal membranes are entirely free from each other, and are not united to the isthmus until they reach its front part. There are six, acinaciform branchiostegal rays, the first of which is extraordinarily small.

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[a] On examination of these tables of measurements, and on comparison of the specimens belonging to the Royal Museum of *Lumpenus medius* with those of *Lump. Fabricii*, which are determined by Prof. Malmgren, the conclusion forces itself upon us that, in these materials at least, we can find no ground for distinguishing between the species. We have failed to find any confirmation of the statement that the breadth of the forehead is less in *Lump. Fabricii* than in *Lump. medius*. From Krøyer's minute descriptions it also seems probable that *Lump. Fabricii* is only the older form of the same species as *Lump. medius*.

[b] Nilsson, l. c. Lilljeborg, following Ström, gives this species the name of *Tångbrosme*.

[c] According to Collett's measurements of an Icelandic specimen in the Museum of Copenhagen.

The scales are small, and at the middle of the body, on the upper half of the sides, above the lateral line, 18 scales may be counted in a transverse row. The scales which cover the tumid (muscular) cheeks, are still smaller. The system of the lateral line is most highly developed on the head, but even there the pores are generally distinct only in the row which runs along the hind margin of the preoperculum, and from this point downwards on the lower side of the branches of the under-jaw[b]. The pores of the lateral line of the body are scarcely distinguishable, but the line runs in a groove straight along the middle of the sides.

The vent lies a little behind the end of the first third of the body. In accordance with the changes of growth mentioned above it is relatively situated farther forward in old specimens than in young. In a specimen 154 mm. long the distance from the vent to the tip of the snout is 37·7 % of the length of the body, in another, 230 mm. in length, 35·7 %.

The pectoral fins seem pointed, when folded; but, when expanded, they prove oval, with evenly rounded margin. Their relative length diminishes with age: while the length of the body increases from 150 to 270 mm., the length of these fins decreases from 10 to $7^{1}/_{2}$ % of that length; but while the length of the body increases from 150 to 230 mm., the length of these fins relatively to the length of the belly between the insertion of the ventral fins and the beginning of the anal fin, suffers but very little change, measuring about 40 % thereof. All the rays are articulated, and all, except the first (uppermost) may be branched; sometimes, however, the last (lowest) ray is also simple. The ventral fins are pointed, and, in young specimens are inserted below and between the bases of the pectoral fins, in older specimens farther forward. The spinous ray measures about $^{1}/_{3}$ of the length of the fin; and of the three soft rays the innermost is the longest, its length diminishing with age from 5 to 3 % of that of the body. The distance between the ventral fins and the beginning of the anal fin varies between 25 and 24 % of the length of the body. The first rays of the long dorsal fin are small, but thick, and gradually increase in length to the 11th or 12th ray, from which point the fin is of uniform height, measuring about $^{2}/_{3}$ of the greatest depth of the body, back to about the 40th ray, and then very gradually diminishes in height. It begins almost in a line with the tip of the opercular flap, and is united by its membrane to the base of the caudal fin. The spinous ray of the anal fin is about half as long as the soft ray immediately behind it. At the beginning, to about the 5th ray, this fin also increases in height, and then becomes straight and of the same height as the dorsal fin, ending in a line with the termination of the latter, and united in the same way to the base of the caudal fin. The caudal fin grows more and more pointed with age. Its length is generally about 10 or 11 % of that of the body, but, according to Stuwitz, may rise as high as 14 %, and thus be nearly half as long again as the head[a].

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[a] Cf. Stuwitz, Kroyer and Lilljeborg. The tubular structure of this papilla is generally more easily distinguished in *Lumpenus Fabricii*. In the Sharp-tailed Lumpenus it is, in most cases, difficult to find any opening at the top of the papilla.

[b] The system of the lateral line on the head is most distinct in young specimens, especially in *Lumpenus Fabricii*, where a row of pores lies in a furrow on each side of the temporal region, from the articulation of the preoperculum to the eye. The preopercular row of pores runs from the end of this furrow, in a downward direction, and, from its beginning, the row belonging to the suborbital ring, is continued forward on the snout, along the lower margin of the preorbital bone. In this species, the lateral line of the body, anteriorly at least, is furnished with distinct pores.

The colouring of the body in the living fish, according to Fries, is superiorly pale brownish, shading into blue, with irregular, grayish brown spots, dotted with a darker colour, and uniting into indistinct, oblique, transverse bands. The lower part of the body is lighter and without spots, shading in front into blue and behind into greenish yellow. A row of about nine oblong, brownish spots follows the lateral line, which is tinged with yellow. The head of the same colour as the body, but without spots. Gill-cover bright green and yellow. Iris brass-coloured with a silvery lustre, but this patch of colour is very narrow superiorly, as a wide strip of the eye is here brownish black. Dorsal fin pale, with transparent membrane, in certain lights with a handsome bluish lustre, and striped with about 12 wavy, pale brown bands, sloping in a posterior direction. Pectoral fins with yellowish rays, and with this exception pale and without spots, like the ventral and anal fins. Caudal fin with 6 indistinct bands — in young specimens only 3 or 4 — of pale brown spots on the yellowish rays.

Pyloric appendages only two, but fairly large. Ovaries united, but in front distinct from each other. In the females we find a small anal papilla, which seems to be prominent, however, only during the spawning-season.

The Sharp-tailed Lumpenus has been found on the coast of Bohuslän on only few occasions, first by B. Fries, who in January, 1837, in the outer part of Gullmaren, took a female 190 mm. long in a seine. Since that time Malm has recorded two captures of this species in the south of Bohuslän; and in May, 1880, Mr. C. A. Hansson found a specimen 154 mm. long in the gullet of a *Gadus morrhua* from the neighbourhood of Strömstad. Almost at the same time as Fries, Stuwitz and Esmark discovered the species in Christiania Fjord. It is of more common occurrence on the west coast of Norway, where it had already been remarked by Ström; and it seems to be most numerous in the extreme north, in Finmark, in which district it was obtained by Lilljeborg in 1848. As early as 1786 it was described and figured by Mohr as an Icelandic species. It occurs in Spitzbergen too, up to 80° N., according to Collett; and it is stated to occur in Greenland by Reinhardt and Krøyer. Thus it is really an arctic species, but also lives in the Baltic, where it was first observed by Mr. G. von Yhlen, who in 1861 sent to the Royal Museum two females, respectively 230 and 274 mm. long, which had been taken in Bråvik. Brenner has subsequently recorded its capture in the summer of 1871, off Hogland in the Gulf of Finland; and Möbius and Heincke have received a specimen 25 cm. long, taken with a Herring-net in Kiel Harbour on the 22nd of November, 1877. Finally Day has added this species to the fauna of Scotland by his description of a specimen which was taken on the 31st of May, 1884, in a trawl, at a depth of 40 fathoms, 15 miles off St. Abb's Head.

With regard to its habits nothing is known, save that it is generally taken in the seine, and therefore in comparatively shallow water and near the coast. The specimen taken by Fries had evidently just deposited its spawn; and the spawning-season thus seems to occur during the winter[b]. (Fries, Smitt.)

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[a] Day gives a figure and description of a singularly-shaped caudal fin in a male of this species, the five middle rays (though perfect) being considerably shorter than the outer ones on each side.

[b] "*Vid jultiden*" (at Christmas), says Nilsson, not "*im Juli*" (Möb., Hcke).

THE BLUNT-TAILED LUMPENUS (SW. TRUBBSTJERTADE LÅNGEBARNET).

LUMPENUS MACULATUS.

Plate XI, fig. 4.

Teeth on the palatine bones and vomer, as well as in the jaws: and among the jaw-teeth, in both jaws, in front, a pair of distinct canine teeth. Length of the maxillary bones more than $^1/_3$ of that of the head. Number of rays in the dorsal fin less than 62, in the anal less than 39. Upper part of the pectoral fins arcuate, lower part elongated, with the rays free at the tip. Caudal fin truncate or slightly rounded.

$R.\ br.\ 6;\ D.\ 58—61;\ A.\ \frac{1}{34-37};\ P.\ 15;\ V.\ {}^{1}{}_{3};\ C.\ x+11+x.$

Syn. *Lumpenus aculeatus*, REINH., Dansk. Vid. Selsk. Naturv. Math. Afd., Deel 6, Overs., p. CX (sine descr.); ID. (*Clinus*), ibid., Deel 7, pp. 114, 122, 194; KRØY. (*Lumpenus*), *Voy. Scand. Lap.*, GAIM., *Poiss.*, tab. 14, fig. 2; GTHR (*Stichæus*), *Cat. Brit. Mus.*, *Fish.*, vol. III, p. 282 (num. rad. pinn. err.); KRØY. (*Lumpenus*), Naturh. Tidskr. Kbhvn, ser. 3, vol. I, p. 268; GILL (*Leptoclinus*), Proc. Acad. Nat. Sc. Philad. 1864, p. 210; ESM. (*Lumpenus*), Skand. Naturf. Möde Christ. 1868, p. 523; GILL (*Leptoclinus*), Smith's Misc. Coll., No. 283, p. 19.

Clinus maculatus, FRIES, Vet.-Akad. Handl. 1837, p. 51; ID., *Skand. Fisk.*, ed. 1, p. 108, tab. 25, fig. 2; KRØY. (*Lumpenus*), *Danm. Fiske*, vol. 1, p. 333; EKSTR. (*Clinus*), Gbgs Vet., Vitt. Samh. Handl. 1850, p. 38; MALM, ibid., p. 90; NILSS. (*Lumpenus*, *Ctenodon*), *Skand. Fn.*, *Fisk.*, p. 190; GTHR (*Stichæus*), l. c., p. 281; GILL (*Leptoclinus*), l. c., 1861, App., p. 45; COLL. (*Lumpenus*), Forh. Vid. Selsk. Christ. 1874, Tillægsh., p. 74; CEDERSTR., Öfvers. Vet.-Akad. Förh. 1876, No. 4, p. 65; MALM (*Ctenodon*), *Gbgs. Boh. Fn.*, p. 470; COLL. (*Lumpenus*), l. c., 1879, No. 1, p. 59; ID., *N. Nordh. Exped.*, *Zool. Fiske*, p. 67, tab. II, fig. 18; LILLJ., *Sv., Norg. Fiskar*, vol. I, p. 500; JORD., GILB., Bull. U. S. Nat. Mus., No. 16, p. 777.

All the specimens of this species that FRIES obtained on the coast of Bohuslän were between 150 and 175 mm. in length. The body is not so elongated as in the preceding species, and of more uniform breadth, only slightly tapering towards the tail, moderately compressed throughout its length, and with broad, rounded, dorsal and ventral edges and a longitudinal depression, as in the preceding species, along the middle of the sides. The greatest depth of the body is from about 8 to 10 % of the length, and the greatest breadth nearly $^3/_4$ of the greatest depth. The head, which measures about 16 or 17 % of the length of the body[a], is somewhat rounded at the top, like the latter, with the snout curved, sometimes tumid with a quantity of the same substance as the so-called adipose membrane, and projecting distinctly in front of the jaws. The cheeks are tumid with strong masticatory muscles. The eyes are large (their longitudinal diameter being about 23 % of the head), turned slightly upwards and only a little distance apart. The length of the snout is about the same as that of the eye, the hind margin of which is consequently placed, as in the preceding species, somewhat in front of the middle of the head. The nostrils are small, and their arrangement the same as in the preceding species; but in this species the two pairs of small openings which have been regarded in this light, one in front of, and one behind, the more distinct dermal tube, are covered and generally hidden by the adipose, membranous integument[b]. The gape is turned somewhat obliquely upwards. The upper jaw, as in the preceding species, is only slightly movable, and does not admit of any protrusion, as the bones which form the jaw, the narrow and linear intermaxillary bones and the maxillaries, are closely united by short ligaments. The maxillaries, which are longer than in the preceding species, and are hardly any wider behind than in front, form a slight S-curve, and extend behind the perpendicular from the centre of the eye. A broad, labial skin is rolled over the intermaxillary and maxillary bones, and the margin of the jaws is somewhat arcuate. The branches of the lower jaw, which is long, and curved slightly upwards, but is still shorter than the upper jaw, are almost parallel. It is only the lower jaw that is moved when the mouth is opened. In the extreme front of both jaws we find large, prominent, canine teeth, one on each side in the upper jaw, and two in the lower. In the upper jaw there is an empty space between them; but in the lower jaw this space is filled by a row of much smaller teeth, behind which the whole front surface of both jaws is set with a card of fine, pointed teeth, which is continued in the upper jaw by a few rows in the margin, the outermost of which is the most distinct, and contains the largest teeth, but in the lower jaw by only one row. Similar teeth occur on the head of the vomer and in a row on each of the palatine bones; the tongue, on the other hand, is smooth with the thin and rounded tip free. In the front part of the palate we find a distinct, transverse, membranous, palatal fold (velum), deeply incised at the middle.

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[a] In small specimens, from 66 to 69 mm. long, according to COLLETT, the length of the head is 17·4 % of that of the body.

[b] Cf. above, p. 84, note *c*.

The gill-openings, as in the preceding species, large. Branchial arches four, the last of which is united to the wall of the branchial cavity. Branchiostegal membrane deeply incised at the bottom and united to the isthmus, with 6 rays. Above the preoperculum, which is closely united to the operculum, lies a strong masticatory muscle, which renders the temples thicker. The end of the opercular margin is truncate, pointing in an upward direction above the upper fold of the pectoral fins, and is continued by a thin, pointed, dermal flap. The base of the triangle formed by the operculum, suboperculum and this flap is considerably less than half the distance from the end of the flap to the hind margin of the eye.

The skin, with its copious secretion of mucus, is covered as in the preceding species, with very small, thin, rounded scales, some of which overlap each other. These scales are scarcely visible, until the mucus has been removed from the skin. The lateral line is indistinct, runs straight along the depression in the sides of the body, about half-way between the dorsal and ventral edges. The vent lies half-way between the snout and the base of the caudal fin. The distance between the anal fin and the tip of the snout is about 45 % of the length of the body.

The dorsal fin begins in front of the pectoral fins — the distance between it and the tip of the snout is about 15 % of the length of the body — vertically above the insertion of the ventral fins, and runs along the back almost to the base of the caudal fin. It consists of hard, pungent rays, the points of which project above the margin of the fin-membrane, which thus acquires a serrated appearance. The first two or three rays are very short and look like independent spines, but in the male are generally united by a membrane, though free in the female. The next ten rays gradually increase in height, from which point the height of the fin remains about the same for half its length, and then diminishes almost imperceptibly towards the end. The upper margin of the fin is thus arched, and its greatest depth is about equal to the diameter of the eye. The anal fin is of almost the same shape as the dorsal, and extends quite as near, or even nearer, the base of the caudal fin. It is only slightly lower, and its lower margin is not so convex as the upper margin of the dorsal fin. The first two rays are usually simple, the first of all being an unarticulated spinous ray; the others, from 33 to 36 in number, articulated and branched at the tip. The pectoral fins are especially singular in shape. When they are expanded, the hind margin is rounded at the top, while at the lower corner five or six long rays project beyond the margin of the fin-membrane. They contain 15 rays each, the uppermost being quite short and simple; the next eight or nine, which are about equal in length and branched at the tip, are united by the thin membrane right out to the point; but the next ray quite suddenly projects a long distance, about $^1/_3$ of the length of the upper rays, beyond the fin-membrane, and is the longest ray in the whole fin. The last four or five rays gradually decrease in length, being of the same structure as the last-mentioned ray, and all bifid at the tip. When folded, the fin is of an oblique, lanceolate shape, measures about 14 % of the length of the body, and lies obliquely in an upward direction. The ventral fins, which are situated a little in front of the pectoral, close to each other, are of the same structure as in the preceding species, narrow, of almost uniform breadth, and in length equal to the lower jaw or about $6^1/_2$ % of the length of the body. The caudal fin is almost equal in length to the depth of the body, is wide and truncate or somewhat rounded at the end, and consists of 11 branched rays and one simple ray on each side, not to mention a few smaller and shorter (supporting) rays just at the base.

The body is of a dirty yellowish colour, darker above and lighter below, marked along the sides above the lateral line with several dark, irregular, yellowish brown spots, which are edged with dark brown, and thus form, as it were, several dark rings, partly broken, and partly coalescent. As a rule, too, we find on the extreme dorsal edge five or six large, dark spots with the appearance of transverse bands. There is a row of smaller and lighter, round spots along the lateral line, and below it appear indistinct traces of similar spots. The ground-colour of the head is the same as that of the body, but the sides are more yellowish, and on the top we find very indistinct traces of spots. The eye is of the same colour as in the preceding species, the iris only being more whitish. The dorsal fin is also pale, with a dash of yellow, and marked on the rays with from 9 to 11 wavy rows of small, round, brown spots, which run obliquely down from the top of the fin in a posterior direction. The anal and ventral fins pale and without spots. The caudal and pectoral fins, on the other hand, have small spots on the rays, forming a few more or less distinct, transverse bands.

The liver is of a pale colour, and is divided at the point into two lobes, both of the same size, or the left somewhat longer than the right, and extending to the bottom of the stomach. It is concave at the top, and is wrapped round the œsophagus, the stomach and the pylorus. The gall-bladder is very small, scarcely larger than a canary seed, and lies between the upper part of the lobes of the liver. The œsophagus is very short, and the stomach small, with the pylorus set laterally in an upward direction and furnished with three, short, conical appendages. The intestine is fairly long, and forms its first curve just in front of the pylorus; behind the bottom of the stomach it forms a slight bend, and then descends in an almost imperceptible curve towards the vent. The air-bladder is wanting. The urinary bladder long, narrow and transparent. The male has two oblong, terete testes, joined to each other, and the female one single ovary, fairly large and cylindrical, and towards the spawning-season full of white ova of the size of poppy seed.

This little fish, worthless to the fisherman, but all the more valuable to the ichthyologist, has been found, in Sweden, only on the north coast of Bohuslän, where it was discovered by FRIES in 1835 at the entrance of Gullmar Fjord, and was subsequently met with annually for some years after, in October, November and December. More recently MALM, CEDERSTRÖM and HANSSON have also found it during these months; and the last-named gentleman has sent to the Royal Museum a specimen which was caught at the end of April, 1887. It has also been ascertained that this species lives along the whole coast of Norway, in Spitzbergen, where the Norwegian Arctic Expedition found it in Magdalena Bay, and in Greenland, where, according to the collections in Copenhagen Museum, it is the most common species of this genus.

It seems to be an inhabitant of deep water during the greater part of the year, and to enter the shallows only in the spawning-season, which occurs during the months mentioned above. As it is never caught in any quantity, but only one or two at each haul of the seine, it is more than probable that, even during the spawning-season, it does not congregate in shoals, but lives in pairs. Immediately after its capture it is very active, and, if put into a vessel of water, makes strenuous efforts to escape, often leaping over the edge of the vessel. Like its near relations, it is very tenacious of life, and may be kept alive for several days in a small vessel, filled with water, if the water be changed daily. It then keeps close to the bottom, with the body extended and the pectoral fins expanded, and apparently supports itself on the free, lower rays of these fins, which, in some way, look like fingers, and serve as feet in the slow, creeping movements of the fish.

The great strength of the jaws indicates that, relatively to its size, the Blunt-tailed Lumpenus is distinctly a fish of prey, though the stomach is empty in most specimens, during the period when it is found on the coast of Bohuslän. In specimens from Greenland KRØYER found the stomach full of Annelids; and COLLETT states that his specimen from Spitzbergen contained several perfect specimens of *Themisto libellula* (a Hyperidian crustacean), and a specimen of one of the scaly Annelids (*Lepidonote*).

The fisherman call this fish *Långebarn* (Ling-child) on account of its small size and resemblance in shape to the Ling. They know quite well, however, that it is distinct from the fry of the Ling. All the specimens obtained by FRIES were taken in a large Herring-seine at the entrance of Gullmar Fjord.

(FRIES, SMITT.)

Fam. ANARRHICHADIDÆ.

External bones of the head smooth. No osseous connexion between the suborbital ring and the preoperculum. Jaw-teeth and palatine teeth of extraordinary strength, partly obtuse molars (on the vomer and the palatine bones, and in the lower jaw), partly conical or curved canines (on the intermaxillary bones, and in the front part — sometimes in the back part as well — of the lower jaw). One continuous dorsal fin along the whole of the back behind the occiput, containing only simple rays. Anal fin also long. Ventral fins wanting. Pseudobranchiæ present. No air-bladder or pyloric appendages.

The singular dentition of the mouth in these fishes led Gill[a] to form a distinct family for them, though they are so like the Blennies in other respects that their union with the preceding family would be by no means unnatural. Of the whole apparatus of the ventral fins the Sea-cats retain only a pelvic bone on each side of the body, attached to the inside of the anterior (inferior) end of the clavicular bone; but a similar reduction of these fins is not uncommon in the preceding family, where the pyloric appendages and air-bladder may also be wanting. But the Sea-cats possess another individual peculiarity in the structure of the dorsal fin, in which the simple, undivided rays in the back part (about 10 or 12 in number) are hardened into true spinous rays, while all the anterior rays are soft-tipped. Another peculiarity of the Sea-cats is the shortness of the intermaxillary bones, which consist almost entirely of the anterior part alone, the posterior (horizontal) branch being both shorter and more slender than the vertical (the nasal process), the point of which is united by a firm, cartilaginous connexion (synchondrosis) to the anterior end of the ethmoid bone, whereas, in other cases, this branch lies free in a groove on the top of the ethmoid bone. Lastly, we find another deviation in the Sea-cats from the general rule among the Anomalopterous fishes, in the circumstance that the number of branched rays in the caudal fin may rise to at least 15, only from 11 to 13, however, being so long that they can be regarded as caudal rays proper, while the other (outer) ones are rather to be considered as branched supporting rays. The system of the lateral line is especially well-developed, though its pores are small and often indistinct. There are two lateral lines proper on each side of the body, one at the middle of the side and the other along the base of the dorsal fin, at a greater or less distance from it; but in the posterior part of the body they can scarcely be detected.

The family contains 6, perhaps 7, species, belonging to northern and high northern latitudes, and distributed between two genera.

Genus ANARRHICHAS.

Caudal fin distinctly separated both from the dorsal fin and the anal.

A groundless tale that the Sea-cat was called *klipp-fisk* (Rock-fish) by the fishermen of the Baltic, because it crept up on the rocks, induced Gesner to give it the name of *Anarrhichas* (climber), and Artedi[b] retained this name for the genus, which is spread over the northern parts of the Atlantic and Pacific. For the elucidation of this genus according to the requirements of modern science we have first to thank Professor Jap. Steenstrup. Within the limits of the Scandinavian fauna three species occur, which may be distinguished as follows:

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[a] Canad. Natur., Geol., Aug. 1855, p. 247.

[b] *Ichth.*, *Gen.*, p. 23.

A: Snout blunt (its upper profile steep). Length of the caudal fin more than $^1/_{10}$ of that of the trunk (excluding the head and the caudal fin):

- *a:* Body dark gray, with black transverse bands .... *Anarrhichas lupus.*
- *b:* Body yellowish or grayish blue, with blackish brown spots .... *Anarrhichas minor.*

B: Snout pointed (its upper profile sloping). Length of the caudal fin less than $^1/_{10}$ of that of the trunk (excluding the head and the caudal fin). Body chocolate-coloured, with indistinct, dark spots .... *Anarrhichas latifrons.*

THE COMMON SEA-CAT OR WOLF-FISH (SW. VANLIGA HAFKATTEN).

ANARRHICHAS LUPUS.

Plate XII, fig. 2.

Length of the head more than $^1/_5$ of that of the body. Length of the pectoral fins more than 13 % of that of the body. The row of vomerine teeth longer than the row on each palatine bone. End of the dorsal fin evenly rounded or (in young specimens) sloping gradually towards the base of the caudal fin (the more or less hard, spinous rays which form this curve, from 10 to 13 in number, diminishing in length uniformly, or, in young specimens, with a slightly marked break). Frontal bones behind the eyes gathered at the top into a ridge. Colouring blackish gray, with more or less distinct black, transverse bands.

R. br. 7; *D.* 70—75[a]; *A.* 45—48[b]; *P.* 18—20[c]; *V.* 0; *C.* $x+12$ l. $13+x$; *Vert.* 74—76.

Syn. *Anarrhichas*, GESN., *Nomencl. Aquat.* (Tiguri 1560) p. 116; *Lupus marinus nostras*, SCHONEV., *Ichth.*, p. 45, tab. V.
Anarhichas Lupus, LIN., *Syst. Nat.*, ed. X, tom. I, p. 247; OLAFS., *Reise Isl.*, I, p. 590; MÜLL., *Zool. Dan. Prodr.*, p. 40; FABR., *Fn. Groenl.*, p. 138; MOHR, *Isl. Naturh.*, p. 63; ASCAN., *Ic. rer. nat.*, cah. III, p. 4, tab. XXV; BLOCH, *Fische Deutschl.*, part. III, p. 19, tab. LXXIV; RETZ, *Fn. Suec. Lin.*, p. 315; HOLLBERG, *Boh. Fisk.*, III Häft., p. 18, cum fig.; NILSS. (*Anarrhichas*), *Prodr. Ichth. Scand.*, p. 108; CUV., VAL., *Hist. Nat. Poiss.*, vol. XI, p. 473, tab. 342; FR. et WRIGHT, *Skand. Fisk.*, ed. I, p. 39, tab. 8, fig. 2; KR., *Danm. Fiske*, vol. I, p. 369; NILSS., *Skand. Fn.*, *Fisk.*, p. 208; GTHR, *Cat. Brit. Mus.*, *Fish.*, vol. III, p. 208; MGRN, *Finl. Fisk.* (disp.) p. 22; COLL., Forh. Vid. Selsk. Chrnia, 1874, Tillægsh., p. 70; STEENSTR., Vid. Meddel. Naturh. For. Kbhvn 1876, p. 200, tab. III, fig. 1; MALM, *Gbgs, Boh. Fn.*, p. 468; WINTH., Naturh. Tidskr. Kbhvn, ser. 3, vol. XII, p. 22; BEAN, Proc. U. S. Nat. Mus., vol. II (1879) p. 218; DAY, *Fish. G:t Brit.*, *Irel.*, vol. I, p. 195, tab. LVIII; MÖB., HCKE, *Fische d. Osts.*, p. 59; JORD., GILB., Bull. U. S. Nat. Mus., No. 16, p. 781; LILLJ., *Sv.*, *Norg. Fisk.*, vol. I, p. 530; HANSEN, *Zool. Dan.*, *Fiske*, p. 46, tab. VII, ffg. 7.

The Sea-cat attains a considerable size. Its length is usually between 4 and 7 dm., but specimens 12 dm. long are occasionally found. The body is elongated and more or less cylindrical; the sides strongly compressed, especially in the caudal region, and the belly pendent. The greatest depth of the body shows even relative increase with age: in specimens from 100 to 400 mm. long it measures nearly 18 % of the length, and in specimens 11 dm. long about 22 %. The head is comparatively small: during early growth, from a length of 100 to about 600 mm., its length sinks from 23 to about $20^1/_2$ % of that of the body; but subsequently seems, even relatively, to increase, being about 22 % of the length of the body in specimens 11 dm. long. The top of the head is rounded, the sides compressed, and the temples and cheeks tumid, thus showing the strength of the masticatory muscles. The snout is short and blunt, and the jaws project about equally. This circumstance, in conjunction with the long, conical front-teeth, gives the head a certain resemblance to that of a cat, and hence is derived the name of the species. The eyes are of moderate size and set high, close to the upper margin of the forehead, and nearer to the snout than to the occiput. In specimens about 100 mm. long the diameter of the eye is about $^1/_3$ of the length of the head, and twice the least depth of the tail; in specimens about 400 mm. long about equal to the latter; and in specimens 11 dm. long the diameter of the eye is only slightly more than half the least depth of the tail. Thus, the changes of growth undergone by these parts of the body, run in opposite directions. Round the eye there is a ring of fine, white pores or dermal openings of the system of the lateral line. Similar pores also occur, in the usual manner, along the lower jaw and on the sides of the head, which are covered with a thick skin, entirely enveloping the bones of the gill-cover. The nostrils are set about half-way between the snout and the eye, one on each side, and are raised into cylindrical dermal tubes. The mouth is middle-sized and furnished with fleshy lips, which form thick folds, especially at the corners. In consequence of the firm, cartilaginous connexion between the strong, but short, intermaxillary bones and the front part of the skull (the point of the ethmoid bone), the upper jaw admits of only slight motion, and the opening and closing of the mouth are performed almost entirely by the lower jaw. On each side of the intermaxillary bones we find two or three strong, conical teeth, widened and grooved at the base, like the tusks of the predatory mammals, but blunt at the top, set one in front of another, and each fastened to a hard osseous socket. Within these teeth is a row of 5 or 6 (in old specimens generally fewer) smaller, somewhat compressed, shorter teeth. On the palate are three double rows of thick, globular teeth, with raised, osseous bases. In the middle row, which contains the largest teeth, and is set on the vomer, there are generally four pairs of teeth with an even, worn surface, the penultimate pair being considerably larger than the others. In each of the lateral palatine rows there are two rows, each containing four or five blunt teeth, those of the one row alternating with the other; and these rows are attached to the two palatine bones. In the front of the lower jaw there are from 4 to 6 tusk-like teeth in a row, and within this row begin the two longitudinal rows of shorter, globular jaw-teeth, molars with flat, worn crown and surface sloping inwards. Of these molars the middle ones are the largest. In the roof of the throat there are three upper pharyngeals on each side, united together into a roundish bone, and furnished with scattered, cardiform, conical and curved teeth; and beneath these two longer lower pharyngeal bones with similar teeth, forming an angle in front. The tongue is fleshy, but short, somewhat pointed and toothless. The four branchial arches are furnished in front with spines covered with skin. The gill-openings are of moderate size and almost vertical. The branchiostegal membranes are furnished with 7 rays and inferiorly united to the isthmus, just below the insertion of the pectoral fins.

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[a] Sometimes 69 or even as many as 77, according to NILSSON.

[b] Generally from 43 to 46, according to LILLJEBORG.

[c] Sometimes 21, according to BEAN.

The body is covered with a thick and tough skin, which at first sight seems to be scaleless and protected only by an abundant, mucous secretion; but on closer examination we find small, round, thin scales, deeply imbedded in the skin and scattered, not contiguous. The lateral line is hardly visible, being most distinct in the anterior part of the body, where the dermal pores which belong to it, are generally clearly marked by their white colour. The line runs almost straight along the middle of the body. The vent is large, somewhat pendent and situated a little in front of the middle of the body.

The dorsal fin begins somewhat in front of the perpendicular from the insertion of the pectoral fins, the distance between it and the tip of the snout being always somewhat less than the length of the head, and runs with fairly uniform height along the back very close to the caudal fin, where it ends in an obliquely truncate and rounded corner. All the rays are simple and unarticulated, but only the last 10—13 are really hard, all the others being soft and flexible at the tip. The whole fin is united by a thick and slimy membrane. The anal fin is of the same shape as the dorsal fin, but scarcely half as high, and ends in a pointed corner vertically below the end of the latter. The first ray is unarticulated, but soft; all the other rays are articulated, the anterior ones being simple, the posterior branched at the tip. The pectoral fins are large and rounded; when expanded, they are almost circular. Their branched, thick, weak and fleshy rays give them a striate appearance, which reminds us of the shell of the scallop (*Pecten*). Their length in proportion to that of the body diminishes with age, varying from about 16 to slightly more than 13 % thereof. The ventral fins are wanting. The caudal fin is small, with rounded tip and 20 or 21 rays, only 13, however, being branched; and only the 11 middle ones extending to the true hind margin of the fin.

We have not remarked any considerable difference between the sexes.

The colour is a uniform dark gray. The sides are marked with more or less distinct, black transverse belts, which vary in number and shape, and are generally composed of a number of confluent, small spots. The belts are continued, though more indistinctly, on the dorsal fin. The colour of the eye is very dark, with a lighter ring round the pupil. The dorsal and anal fins are marked with oblique, black streaks.

All the new-caught specimens we have seen, have been of this colour. If the fish is exposed to the air for some time, or left to lie among other fishes in the boat, the colour becomes bleached; and it thus happens that the one side, that on which the fish has lain, or which has been covered with other fishes, may partly or wholly lose colour, while the colour of the other side is more or less perfectly retained. This is a change to which most fishes are liable; and caution should, therefore, always be employed in the determination of new colour-varieties. That there may be such varieties of the Sea-cat[a], we do not intend to dispute; but several of those which have been considered in this light, were evidently due to this cause. During youth the colouring of the body is lighter, and more like that of the following species. The spots which form the transverse bands are then more prominent, many of them being as large as the pupil. The greater distinctness of the spots, and the break at the end of the upper margin of the caudal fin which we have already mentioned, in young specimens of this species, indicate the developmental relations in which it stands to the following species.

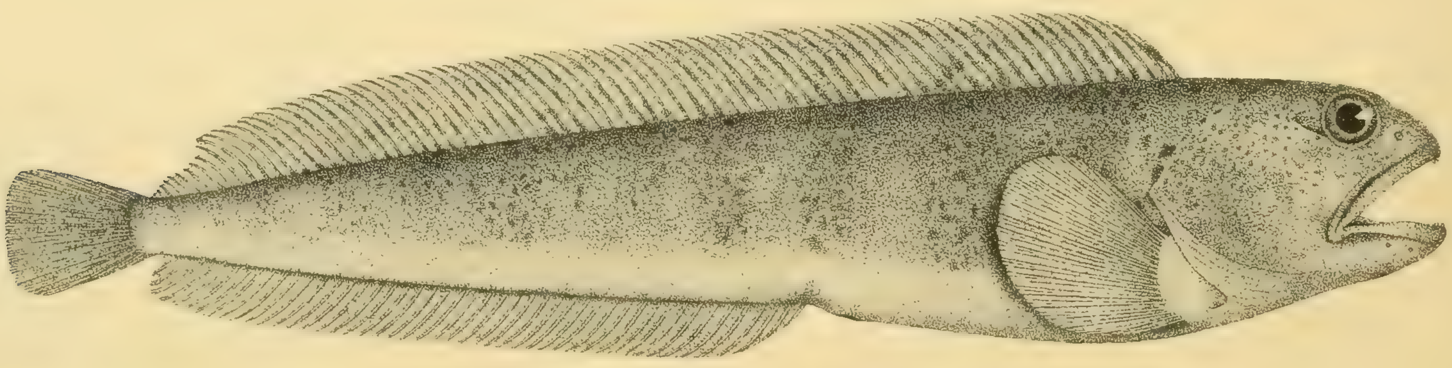

Fig. 62. Young *Anarrhichas lupus* from Bohuslän. Natural size.

The Sea-cat has a fairly wide, muscular œsophagus, which opens into a somewhat saccate stomach, near the bottom of which lies the pylorus. There are no pyloric appendages whatever. The intestine is long, wide and of a thin and fragile texture. It forms three bends, and ends in a short, widened rectum, like a reversed cone. The air-bladder is wanting. The liver consists either of two lobes, of fairly equal size and closely united, or of three, the middle one lying transversely across the anterior end of the abdominal cavity, and the left being twice as long as the right and also narrower and more pointed. The two ovaries are posteriorly united and are furnished with a wide opening duct.

The Sea-cat is one of those fishes of which the old writers have collected a number of fictitious accounts, which have been transferred from one book to another. Both its generic name, *Anarrhichas*, and its specific name, *Lupus*, have originated from the false ideas entertained of the habits of this fish. Gesner, as we have remarked above, in the middle of the seventeenth century gave it the former name, which means *climber*, in accordance with an old tradition that the fish climbed up rocks and cliffs. Linnæus retained *Lupus* as the specific name from the old name *Lupus marinus*, under which the Wolf-fish had been generally known and dreaded. Even in Hollberg (l. c.) we find the following paragraph, quoted from Lacepède: "Cruel as the Shark, it works terrible havoc among its own genus, and displays the same voracity in the piscine world as the wild-beast from which it derives its name, among the defenceless herds." We give this quotation only as a specimen of the old prejudice against this fish for its rapacity, and of the length of time for which, when once rooted, such a prejudice may endure. The Sea-cat is anything but a fish-of-prey, in the meaning generally attached to the term. To convince oneself of this, one need only examine its remarkable dentition, large masticatory muscles and short jaws, which do not admit of the wide opening of the gape which characterizes the true fishes-of-prey or those colloquially called voracious (*svalgfiskar*). The structure of the mouth, on the contrary, belongs to a creature that lives on very hard substances, which must be crushed before they can be swallowed. It is difficult to conceive a crushing-machine more suited to its purpose than the masticatory organs of the Sea-cat, provided that in addition to the crushing of the hard substances it is not required that they should be ground fine. Of the power of the jaws one may convince oneself by opening the stomach, which may be chock-full of crushed, thick-shelled mussels. The food of the Sea-cat consists chiefly of mussels and other shell-fish. It eats them in great quantities, and the thin-walled intestine is often full of thin shells. It does not despise the larger crustaceans — it seems to be especially fond of large hermit-crabs — sea-urchins and star-fish, with which the seas where it lives, abound; but apparently leaves its companion fishes in peace, being perhaps of too sluggish temperament to trouble them. It seems hardly probable that the Sea-cat attacks other creatures than those of which its food is composed; but in Olsen's *Piscatorial Atlas* (1883) divers are warned against meddling with this fish in the water, as in that case they cannot avoid being assailed by it; and in Brown-Goode (*Fisheries and Fishery Industries of Unit. States*, sect. I, p. 249) we read that the Sea-cat is known to have attacked persons wading at low-tide in the shore-pools among the rocks at Eastport, Maine.

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[a] Cf. Hollberg, l. c., p. 25.

The Sea-cat, which in Norway bears the name of *Steenbider* (Stone-biter), occurs along the whole west coast of Scandinavia, from the Sound to the extreme north of Norway. It also lives on the Murmanian coast and in the White Sea, and is common in Iceland and Greenland. On the American side of the Atlantic it has been found as far south as Cape Hatteras. On the European side it is common in the North Sea, but becomes rare on the west coast of France. It seldom enters the Baltic, but has been found in the neighbourhood of Stralsund, in Kiel Bay and off Travemünde (Möb., Hcke). On the west coast of Sweden it cannot be regarded as rare; but as it leads a solitary life, it is nowhere taken in large numbers, only few specimens being occasionally caught. That it is a stationary fish in Sweden, appears from the fact that it is taken all the year round, though oftenest, according to Malm, from March to May, according to Fries, from May to June.

The long, soft body, tapering tail and small caudal fin of the Sea-cat probably render it a poor long-distance swimmer. Its movements too, are sinuous, like those of the Eel, and in general slow. It keeps close to the bottom, generally at a depth of from 10 to 25 fathoms, hidden among stones or seaweed. It is fond of lying still, with the body doubled up. The spawning-season is stated to occur in spring, the time of year when it is oftenest taken.

There is no special fishery for this fish. The Sea-cats which are occasionally taken, are generally caught on the hooks used in Cod-fishing, sometimes in nets and also in the Herring-seine. In spite of the fact that their smell is highly repulsive to most people and their appearance by no means prepossessing, they are a favourite article of food among the fishermen of Bohuslän, who always regard a Sea-cat as a good catch, and its liver, in particular, as a delicacy. "Stewed and prepared like the Burbot, the Sea-wolf (*hafsvarg*)," as Hollberg called it, "is very good, and in flavour can scarcely be distinguished from the former . . . On Oroust and Tjörn the peasants make a kind of porridge of the *hafskuse*" (Sea-king, as it is called on these islands). In the towns there is less demand for it, and it is therefore more seldom offered for sale. However, not only the flesh, but also the strong skin is of comparatively high value.

When caught, the Sea-cat must be handled carefully, at the risk of a bite from its powerful jaws; and it keeps firm hold of whatever object it has once got between its teeth. On this account the fisherman generally gives it its death-blow before he ventures to free it from the hook. In some places it is the custom to chop off the snout at the eyes, before exposing the fish for sale, as the hunter cuts off the head of the hare he has shot, before taking it home. In the London fish-markets the Sea-cat, skinned and with the head cut off, is often offered for sale. (Fries, Smitt.)

THE SPOTTED SEA-CAT (SW. TIGERFLÄCKADE HAFKATTEN).

ANARRHICHAS MINOR.

Plate XIII, fig. 1.

Length of the pectoral fins more than 13 % of that of the body. Row of vomerine teeth longer than any of the palatine rows. The dorsal fin ends in a suddenly depressed, lower part, which extends to the base of the caudal fin (the last 3—6 spinous rays are uniform in length, but short, and the next 14—12 rays in front of them, anteriorly diminishing in stiffness, but increasing in length, form a curve in the fin margin like that in the preceding species). Top of the frontal bones behind the eyes about equal in breadth to the interorbital space. Coloration brownish or yellowish, with large, blackish brown spots.

R. br. 7; *D.* 74—78; *A.* 45—47; *P.* 21—22[a]; *V.* 0; *C.* $x+12-14+x$; *Vert.* 78 l. 79.

Syn. *Hlyre og Steinbits-Broder*, Anarrhichas (minor) maculis nigris rotundis totus conspersus, OLAFSEN, *Reise Isl.*, vol. I, p. 592, tab. XLII; *An. minor*, MÜLL., *Zool. Dan. Prodr.*, p. 40; FABR., *Fn. Groenl.*, p. 139; MOHR., *Isl. Naturh.*, p. 64; STEENSTR., Vid. Meddel. Naturh. For. Kbhvn, 1876, p. 200, tab. III, fig. 2; COLL., Vid. Selsk. Forh. Christ., 1879, No. 1, p. 45; BEAN, Proc. U. S. Nat. Mus., vol. II (1879), p. 217; SP. SCHNEID., Tromsö Mus. Aarsber. 1882, p. 21; JORD., GILB., Bull. U. S. Nat. Mus., No. 16, p. 781; LILLJ., *Sv., Norg. Fiskar*, vol. I, p. 540.

Anarrhichas pantherinus, ZOUIEW, Acta Acad. Sc. Petrop. 1781, part. I, p. 271, tab. VI; MGRN, *Finl. Fisk.* (disp.), p. 23; ESM., Forh. Skand. Naturf. Möde Christ. 1868, p. 524; COLL., Forh. Vid. Selsk. Christ., 1874, Tillægsh., p. 70.

Anarrhichas leopardus, AG., *Gen.*, *Spec. Pisc. Bras* (SP., MART.) p. 93, tab. LI (vide STEENSTR., Vid. Meddel. Naturh. For. Kbhvn 1877, p. 109).

Anarrhichas Eggerti, STEENSTR., Förh. Skand. Naturf. Möte, Sthlm 1842, p. 647.

As STEENSTRUP has pointed out, the specific name (*minor*) by no means denotes that the Spotted Sea-cat (*Flek-Steenbit*, on Vardö) is smaller than the other species of the genus[b]. On the contrary, this species, according to ESMARK, is the largest of all, attaining a length of 2 yards (18 dm.). In external shape it is so like the preceding species that a special description seems hardly necessary, seeing that we can refer to the figure and the above specific diagnosis. The colouring of the body, the structure of the end of the dorsal fin and the form of the skull are the main differences; but even OLAFSEN and MOHR also knew that the Spotted Sea-cat has smaller jaw-teeth and palatine teeth, which are more pointed, or, at all events, not so depressed at the top. In this respect the Spotted Sea-cat is an intermediate form between the preceding and the following species; and STEENSTRUP has shown that this reduction in the strength of the dental equipment is accompanied by a diminution of the surface of origin for the masticatory and respiratory muscles, on the sides of the posterior frontal region, the length of which is here less than the diameter of the orbit (in the preceding species about equal to it).

No external difference of sex is known in this species, any more than in the preceding one: but that there is such a difference, seems more than probable, considering the great individual variations which meet us, both in the ground-colour of the body and in the position and extent of the anal fin. Of the two specimens presented to the Royal Museum by Baron NORDENSKIÖLD, from DICKSON'S second expedition to Greenland, the one, which is 68 cm. long, is of a ground-colour best described as chocolate, all over the body, here and there with a dash of yellow; while the distance from the anal fin to the tip of the snout is nearly 45 % of the length of the body. In the other specimen, which is 82 cm. long, the ground-colour of the hind part of the body is grayish-yellow, while the front part is more chocolate-coloured; and the distance from the anal fin to the tip of the snout is 49 % of the length of the body. The dark spots are blackish brown in both specimens, the condition of which, however, is such that it is now impossible to determine their sex. This was also unfortunately the case with a specimen extraordinarily well-preserved in external respects, which the Royal Museum received through Mr. SPARRE-SCHNEIDER, from Vadsö, and which was the original of our figure. Its length was 914 mm. In this specimen too, the distance between the anal fin and the tip of the snout is less than half the length of the body; and thus *Anarrhichas minor*, like the preceding species, is probably distinguished in this respect from the following species; but the variations in the specimens from Greenland mentioned above throw a doubt on the constancy of this character. In Todd's figure of *An. minor* (in Bean, l. c.) the beginning of the anal fin is also very near the middle of the body. In our specimen the row of vomerine teeth is scarcely any longer than the palatine rows. The former row, which consists of six teeth, the two posterior pairs being obtuse (the one tooth of the innermost pair even flat), the front pair obtusely pointed and showing more lateral compression than the others, is 28·5 mm. long; while the row on the right palatine bone is 28 mm. long, and consists of 10 pointed teeth. All the teeth are red — Stenstrup explains this as due to the circumstance that sea-urchins compose the chief food of the fish —, but the jaw-teeth and palatine teeth are white at the point.

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[a] According to LILLJEBORG 24.

[b] "The term *Minor* here means *Brother* or *younger Brother*, as in the famous classical names *Cato minor*" etc.

The Spotted Sea-cat has long been known in Iceland and Greenland as a still more useful fish than the preceding species. Zouiew was the first to describe it as belonging to the White Sea and the north coast of Russia; and Esmark the first to publish an identification of the European *Anarrhichas pantherinus* with the *Hlyre* of Iceland. In the North this species is more common than the preceding one — off Vardö, according to Sparre-Schneider, it is taken in large quantities —; but southwards its geographical range seems to end in the neighbourhood of Bergen. On the American coast it has been met with in the Bay of Fundy[a]. It seems generally to keep to deep water, descending to at least as great a depth as 200 fathoms (Collett). Its food is of the same nature as that of the preceding species.

THE BLUE SEA-CAT (SW. BLAA HAFKATTEN).

ANARRHICHAS LATIFRONS.

Plate XIII, fig. 2.

Length of the pectoral fins less than 13 % of that of the body. Vomerine row of teeth shorter than the row on each of the palatine bones. The dorsal fin ends in an even curve down to the base of the caudal fin. Top of the frontal bones behind the eyes at least as broad as the interorbital space. Colouring dark grayish brown or a lighter chocolate-colour, with indistinct, round or rounded quadrangular, black spots, partly arranged in slightly marked, transverse bands across the back.

R. br. 7; *D.* 77—79; *A.* 45—47; *P.* 20—22; *V.* 0; *C.* $x+14+x$; *Vert.* 79—81.

Syn. (?) *Anarrhichas denticulatus*, Kröyer, *Voy. Scand.*, *Lap.*, Gaim., tab. 12, fig. 1; Id., Overs. Vid. Selsk. Forh. Kbhvn 1844, p. 140; Gthr, *Cat. Brit. Mus. Fish.*, vol. III, p. 211.
Anarrhichas latifrons, Steenstr., Förh. Skand. Naturf. Möte, Sthlm 1842, p. 647 (sine descr.); Id., Vid. Meddel. Naturh. For. Kbhvn, 1876, p. 201, tab. III, fig. 3; Coll., Forh. Vid. Selsk. Christ., 1879, No. 1, p. 46, tab. II; Bean, Proc. U. S. Nat. Mus., vol. II (1879), p. 218; Sp. Schneid., Tromsö Mus. Aarsber. 1882, p. 21; Jord., Gilb., Bull. U. S. Nat. Mus., No. 16, p. 782; Lillj., *Sv.*, *Norg. Fisk.*, vol. I, p. 546; Coll., N. Mag. Naturv., Christ. 1884 (Bd. 29), p. 67.

Obs. On reading Collett's description (Forh., l. c., 1879, p. 57) of the teeth in *Anarrhichas latifrons*, and comparing it with Kroyer's figures of the teeth in *Anarrhichas denticulatus*, we find so close a correspondence between them that we can hardly escape the conclusion that they both refer to this species. Nor is Kroyer's figure of the external appearance of the fish incompatible with this opinion, especially if we remember Steenstrup's observation (Vid. Meddel., l. c., p. 179) that this figure is probably drawn from a badly-preserved specimen, the snout of which may very likely have been flattened. Still, in this figure the caudal fin, the pectoral fin, and the head are longer than in *Anarrhichas latifrons*, according to our present knowledge of it; and we ought, therefore, not yet to deny the possibility of grounds for Steenstrup's assumption that a fourth species of this genus may await our further investigations, and that for it should be reserved the name of *An. denticulatus*.

This species too, with our present knowledge of its individual peculiarities, is externally very like the two preceding ones. The snout, however, is more pointed. The deeper form of the body, the greatest depth being more than 22 % of the length, may also occur, according to Bean's measurements, in large specimens of *Anarrhichas lupus;* and in this case the character which might otherwise be employed, that in the

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[a] Brown-Goode, *Fish. a. Fish. Industries of U. S.*, sect. I. p. 249.

Blue Sea-cat the length of the head is less, in the two preceding species greater than the greatest depth of the body, loses its validity. The same remark applies to the character which might else be derived from the greater breadth of the interorbital space in *An. minor* and *An. denticulatus*, which, as a rule, is more than $^1/_5$ of the length of the head, while in *An. lupus* it is less. But in the largest specimens of the latter species measured by BEAN, the breadth of the interorbital space is nearly 25 % of the length of the head. In the dental equipment of the mouth, on the other hand, the Blue Sea-cat is always distinguished by the smaller and more pointed, or at all events conical, but more numerous palatine teeth. The palatine rows are also distinctly longer in every case than the vomerine row. In the specimen from which our figure is drawn, and which we have received from Vadsö by the kind co-operation of Mr. SPARRE-SCHNEIDER — the largest specimen he had even seen — the row on the left palatine bone was 30 mm. long and contained 11 pointed teeth of fairly uniform size, while the vomerine row was only 21 mm. long and contained 6 blunt molars, the first pair, however, being somewhat pointed. Another internal character of this species which was first observed by STEENSTRUP, is the greater breadth of the top of the skull and the more spongeous nature of the frontal bones, in which respect the three species form a series, with *An. minor* in the middle. STEENSTRUP has also pointed out the singular form of the rays of the dorsal fin in the Blue Sea-cat. They are anteriorly convex and posteriorly concave, thus being sectionally crescent-shaped. The front ones, at least, are also extraordinarily broad at the base; and COLLETT remarks that it is chiefly this circumstance, in conjunction with the thick envelope of adipose tissue, that causes the remarkable thickness of the dorsal fin throughout its base, which is so prominent in this species that the boundary between the dorsal fin and the body is almost imperceptible.

In colour the Blue Sea-cat is an intermediate form between the two preceding species. It is without the transverse bands which are generally so distinct in the common Sea-cat, but the black spots which appear in the Spotted Sea-cat, are also present here, though only indistinctly visible on the dark brown ground-colour. The cavity of the mouth is for the most part grayish black (COLLETT); but in the specimen mentioned above both the anterior part of the mouth and the back wall of the gill-openings were pure white.

The most important distinction between this species and the two preceding ones, however, is of economical nature. "In the quality of the flesh," says SPARRE-SCHNEIDER, "it differs considerably from its kindred species: even the Russians regard it as uneatable, and most of the specimens taken are therefore thrown away at once, though I have seen a few flayed and hung up to dry." In Iceland the *Blágóma* (STEENSTR., Vid. Meddel., l. c,, p. 164) enjoys no greater esteem; and it therefore seems highly probable that the fishermen of the North distinguished between three species of Sea-cat, two edible and one inedible, long before the zoological determination was made.

The Blue Sea-cat occurs on the coasts of Greenland and Iceland, as well as in Norwegian Finmark. In the more southern parts of Scandinavia it is unknown. It attains a length of about 11 dm. Our specimen was 1,105 mm. long. Its home is the same as that of the preceding species — at all events it is taken among them in deep water; but the difference in its dentition undoubtedly indicates that its food is also in some way different. SPARRE-SCHNEIDER found in the stomach of all the specimens which he examined, nothing but the offal of Codfish, which he supposed had been thrown overboard by fishermen who had gutted their catch at sea.

GOBIOMORPHI.

Body, anteriorly at least, terete or even depressed, in the remaining part elongated and low or bulky and fairly deep. The great majority of the rays of the unpaired fins soft; anterior (spinous-rayed) part of the dorsal fin shorter than the posterior (soft-rayed), and generally with flexible spinous rays, sometimes hidden under the skin or entirely wanting. Ventral fins thoracic or jugular, well-developed and sometimes free from each other, but generally united in a funnel-shape or together forming an adhesive disk[a]. *Pectoral fins with broad basal bones. Branched rays of the caudal fin generally few (under 13); but sometimes even the supporting rays of this fin are branched. Suborbital ring generally without any osseous connexion with the preoperculum. Vomer and palatine bones in most cases toothless. Anal papilla well-developed, at least in the male. Scaly covering of the skin extremely variable: sometimes abundant and regular, consisting of thin ctenoid or cycloid scales, sometimes verrucose or tubercular; while sometimes there are no scales on the highly muciparous skin.*

This series of families, corresponding to GÜNTHER'S[b] two series, *Gobiiformes* and *Gobiesociformes*, is composed of distinct bottom-fishes, most of which live on the sea-coast, and only a few occur in fresh water. Like the Blennomorphs, these fishes are also, in general, tenacious of life, as the relatively small size of their gill-openings enables them, though out of the water, to retain the moisture on their branchial lamellæ for some time. The abundant mucous secretion of the skin, which is so common in these fishes, also contributes to this result. Like most of the Blennomorphs, the majority of the Gobiomorphs also have no air-bladder. The difference in the development of the ventral fins, as well as in the structure of the rays of the dorsal fin, however, renders this series of fishes a sharp contrast to the preceding one. The most remarkable peculiarity of this series also lies in the employment of the former fins (the pelvic apparatus), and also in the reduction which sometimes appears in the spinous-rayed part of the dorsal fin.

The series corresponds to MÜLLER'S[c] family *Gobioidei*, with the exception of *Echeneis*.

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[a] In *Oxuderces*, a Chinese species, however, the ventral fins are wanting.

[b] *Systematic Synopsis, Cat. Brit. Mus., Fish.*, p. VII (*Acanthopterygii Gobiiformes*) and p. IX (*Acanthopterygii Gobiesociformes*): *Introd. Stud. Fish.*, pp. 483 and 510; *Handb. d. Ichthyol.*, pp. 343 and 363.

[c] Abh. Akad. Wiss. Berlin 1844, Phys. Abh., p. 158.

Fam. GOBIIDÆ.

Body elongated, terete or with the caudal part compressed, head sometimes depressed. Dorsal fin-formation regular, continuous or divided into two fins, with the anterior part or fin shorter than the posterior and consisting of flexible, simple rays[a]. *Anal fin in structure and extent analogous to the soft-rayed part of the dorsal fin or the posterior dorsal fin. Ventral fins with 6 (seldom 5) clearly distinct rays, the outermost being simple, the inner ones branched, and the innermost (hindmost) ones usually the longest. Pseudobranchiæ present, but sometimes only rudimentary. Number of vertebræ from 27 to 29. Air-bladder and pyloric appendages generally wanting. No osseous connexion between the suborbital ring and the preoperculum.*

This family, as established by GÜNTHER[b], is one of those containing the greatest number of species — about 500 are entered in the system — even though future researches may show, as seems highly probable, that many of these species are really only nominal. The variations of form within the family are also sufficiently marked to have given rise to the establishment of several subfamilies — GÜNTHER[c] adopts four — two of which are represented in the Scandinavian fauna. Here, however, we may follow RICHARDSON and BLEEKER in treating the one of these subfamilies as a distinct family.

Subfamily GOBIINÆ.

Ventral fins set close together. Vertical fins distinct. Gill-openings lateral.

The greater part, about 450, of the species belonging to the family range themselves in this subfamily. In a great number of them, about 100 species, corresponding chiefly to BLEEKER'S *Eleotriformes*, the ventral fins are indeed set close together, but are entirely or at least partly separate from each other. Some of these fishes, the genera *Periophthalmus* and *Boleophthalmus*, are of especial interest on account of their singular manner of life, which, like that of the well-known *Climbing-fish* (*Anabas*), displays at its highest the capability of fishes of adapting themselves to circumstances foreign to their nature. These two genera belong to the Tropics, where they live between high and low water-mark or in fresh water near the sea. But water is hardly their true element, for they are generally found on land, where they, generally at least, seek their food. Their relatively narrow gill-openings enable them to sustain life for a long time in the air, and their pectoral fins are brachiate and fleshy at the base, being thus transformed into organs of creeping or hopping. The eyes, which project from their sockets, are protected by a dermal fold, a kind of lid. Such is their equipment for the life they lead, hopping about on clayey or muddy ground in chase of insects or crustaceans, or even leaping up on the branches of trees or the roots of the mangrove. Sometimes they may be seen in shoals, tumbling about or hopping, as if in sport, on the muddy ground, and at the approach of danger burying themselves in the mud, or seeking shelter in a hole burrowed by a crab or a crevice between the stones. Even OSBECK has described this singular phase of piscine life[d].

The nucleus of the subfamily, the greater part of BLEEKER'S *Gobiiformes*, on the other hand, consists of the forms which have the ventral fins united by a membrane into a funnel-shaped instrument of adhesion. To this division belong all the species of this subfamily that occur within the limits of the Scandinavian fauna.

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[a] As a rule, this part of the dorsal fin-formation is shorter in the female than in the male, and in one of the Scandinavian species it is wanting in the females.

[b] *Cat. Brit. Mus.*, *Fish.*, vol. III, p. 1.

[c] BLEEKER (Arch. Néerl. Sc. Ex. Nat., tome IX (1874), pp. 289 etc.) has an entirely different determination for his four subfamilies; but (as well as GILL: Smiths. Misc. Coll., No. 247, p. 6) he also ranges *Callionymus* and *Platyptera* in two distinct families.

[d] *Ostindisk Resa*, p. 130. Cf. also DUSSUMIER in CUV., VAL., *Hist. Nat. Poiss.*, vol. 12, p. 186, and PECHUEL-LOESCHE in BREHM'S *Thierleben*, Bd. 8, p. 123.

The membrane that unites the two ventral fins, may sometimes be wanting in front; and WINTHER[a] attempted to make the presence or absence of this membrane a generic character. But as it may be wanting in specimens of these species[b] perfectly typical in other respects, we can regard this only as an individual departure from the normal structure of the genus.

One of the most remarkable peculiarities of this subfamily is the structure of the system of the lateral line. The system is not without the so-called muciferous ducts[c]. In *Gobius niger* for example, these ducts with their pores appear on the head, both in the hind margin of the preoperculum, on the parietal sides and the forehead (in a line from the upper corner of the branchial opening to the middle of the hind margin of the eye), between the eyes and on the snout, on the inner side of the nostrils. SOLGER[d], however, searched in vain for sensory organs in these ducts. On the other hand, the cheeks, the branches of the lower jaw, the gill-cover, the occiput, and one row of scales on the sides of the body or, at least, some of the scales in that row which corresponds to the lateral line, are furnished with external, small papillæ, which have the appearance of sensory organs, and are arranged in more or less regular rows. The histological structure of these sensory organs, composed, as they are, partly of indifferent, epithelial cells and partly of pear-shaped, sensory cells, tipped with bristles, which project into the cupula covering the top of the organs and filling a cavity bare of epidermic cells, corresponds to the structure ascribed by F. E. SCHULTZE[e] to the sensory organs of the lateral line proper and the other parts of this system. The position of these organs, which lie uncovered on the surface of the skin, represents the earlier developmental stages of the system of the lateral line, as SCHULTZE has shown, before it is furnished with ducts, originally channelled, and at length perfected by the coalescence of the dermal folds which have risen on each side of the sensory organs already present. Similar free, "embryonal", lateral organs also occur in the fry of the Pike and the Sticklebacks[f], and may perhaps be present in many other fishes, especially those in which the lateral line is indistinct or broken; but nowhere are they so distinct as in some members of the subfamily *Gobiinæ*.

The generative organs of these fishes call for special attention. In the male of the Common Scandinavian Goby (*Gobius niger*), during the spawning-season, the testes are considerably expanded posteriorly, lobate and of a spongeous structure with relatively large meshes. The two hindmost lobes, one on each testis, or sometimes three — one of them in this case being unpaired, and issuing from the union of the *vasa deferentia*[g] or belonging to the left testis — issue from the testes proper in the form of flat, triangular disks with rounded corners, which are considerably broader and even thicker than the latter, but like them open into the *vasa deferentia*. RATHKE described them[h] under the name of auxiliary generative organs, and explained their function partly as prostatic formations,

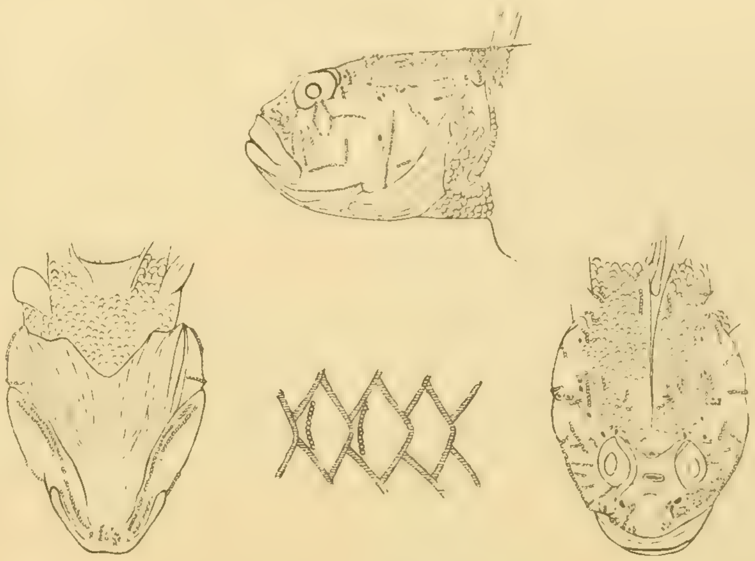

Fig. 63. Dermal papillæ on the head (magn. 1 1/2 diam.) and on two of the scales of the left lateral line (magn. 6 diam.) in *Gobius niger*. After WINTHER.

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[a] Naturh. Tidskr. Kbhvn. ser. 3, vol. XI, p. 49.

[b] In a *Gobius pictus* (AUCTT.) from Allinge (Bornholm) the membrane which in other cases unites the ventral fins, is so small and thin, that it was only after the minutest examination that we could find any traces of it.

[c] Cf. CUV., VAL., *Hist. Nat. Poiss.*, vol. XII, pp. 33 and 87; WINTHER, Naturh. Tidskr. Kbhvn. ser. 3, vol. IX, p. 181, plate VII.

[d] Arch. Mikr. Anat., Bd. XVIII (1880), p. 377.

[e] Arch. Mikr. Anat., Bd. VI (1870), pp. 62 etc., plates IV—VI.

[f] LEYDIG, *Neue Beitr. Anat. Kenntn. d. Hautdecke und Hautsinnesorgane der Fische*, Festschr. z. Feier d. Hundertj. Best. d. Naturf. Gesellsch. in Halle a/S, 1879. See also SOLGER, l. c.

[g] According to RATHKE.

[h] *Über den Darmkanal und die Zeugungsorgane der Fische*, p. 201, tab. V, fig. 9—11, in Beitr. z. Gesch. d. Thierwelt, Abth. 2 (Schr. Naturf. Ges. Danzig, Heft. III, 1824). Cf. also KROYER, *Danm. Fiske*, vol. I, p. 395.

partly as spermatic vesiculæ. In the females no corresponding structure appears, except that the posterior part of the left ovary is often more or less distinctly separated from the remainder by a fold, being bent downwards and slightly forwards. In the female, however, there appears another peculiarity: the eggs are enveloped in a special covering, which at the same time serves as an instrument of adhesion. This covering consists of an oval capsule (fig. 64), which, as long as it is retained in the ovary at least, is transparent; and within it the egg lies in a perfectly transparent fluid, in which, however, there float a number of more solid, refractive granules which collect in a girdle round the egg in the middle of the capsule. To the thick end of the capsule is attached the adhesive apparatus, which is shaped like a frill or cap, formed by a great number of contiguous, transparent filaments concentrically arranged round this pole. In the ovary we have always found this frill hanging down over the capsule; but when the capsule leaves the fish, the frill is turned up, and the filaments spread, attaching the capsule to some object, with the thick pole as fastening-point[a].

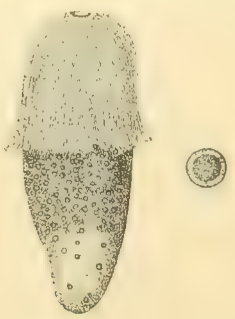

Fig. 64. Ovicapsule from the ovary of a *Gobius niger*, taken on the 19th of July, 1877, in the island-belt of Gothenburg; together with the egg enclosed in the capsule. Magn. 33 diam.

The Scandinavian *Gobiinæ*, which are all without palatine or vomerine teeth, belong to three genera, which may be distinguished as follows:

A: First dorsal fin with at least 5 rays.	
a: Jaw-teeth in several rows . .	Genus *Gobius*.
b: Jaw-teeth in one row, with single canines within this row .	Genus *Aphya*.
B: First dorsal fin with two rays or rudimentary...	Genus *Crystallogobius*.

Genus GOBIUS.

The fairly elongated body for the most part covered with ctenoid scales, but anteriorly (on the head and the parts just behind it), during youth at least, naked or with cycloid scales. Simple, but firmly set, pointed teeth in a card or in several rows in the lower jaw and on the intermaxillary bones. First dorsal fin with at least 5 rays. Ventral funnel united to the ventral side only at the base. Gape relatively small, and the jaws so short that the least depth of the tail is generally more than $^2/_3$ of the length of the lower jaw, which in all the Scandinavian species is less than $^1/_2$ the length of the head. A relatively broad part of the branchiostegal membrane united to the isthmus or to the corresponding membrane on the other side, the gill-openings being thus more or less vertical. Branchiostegal rays 5. Where the air-bladder is present, it is usually small.

It is the giants and pigmies among the vertebrates that generally cause the systematizer most trouble. A great part of the genus *Gobius* must be ascribed to the latter class. However various may be the opinions as to the limitation of the species, in any case this genus, which was first established by Artedi[b], in the form in which it has been adopted by Günther[c], with nearly 300 described species, is sufficiently large to require division, if only on the score of convenience. An attempt to accomplish this has been most thoroughly made by Bleeker[d]. Whether the 36 genera which he adopted, all have a right to their position, is, however, a matter of doubt, and in the Scandinavian fauna of little importance.

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[a] Cf. Malm, *Gbgs. Boh. Fn.*, p. 442, tab. II, figs. 2 and 3.

[b] *Gen. Pisc.*, p. 28.

[c] *Introd. t. Study of Fish.*, p. 486; *Handl. d. Ichthyol.*, p. 345.

[d] Arch. Néerl., l. c.

The Scandinavian Gobii may most easily be distinguished from the two following genera by the number of rays in the first dorsal fin, which in the former, as a rule, is not under 6; but the most universal character lies in the arrangement of the jaw-teeth in several rows, the front row containing the largest teeth. The size of the gape and the form of the body, which shows strong lateral compression only in the caudal part and sometimes only at the extreme end thereof, are with these exceptions the most striking characters of the true Gobies. The branchiostegal rays are 5 in number, the three middle ones being closer to each other at the base than to the other two, and the second (the next to the lowest) generally marking with its point the angle at which the branchiostegal membrane turns inwards to its union with the isthmus, on about a level with the lower end of the base of the pectoral fin.

The differences between the sexes have been remarked in particular by Malm[a] and Heincke[b]. In the males, which may also be recognised externally by their longer and more pointed genital papilla, one or more of the anterior rays in the first dorsal fin, and the posterior rays in both the second dorsal and the anal fins, are, as a rule, elongated. In colour they are distinguished by the greater abundance of black pigment, especially in the anal and ventral fins, by ocellate spots and by stripes of a particular colour on the dorsal fins and the sides of the body. But these sexual differences vary according to age and size, the older and larger females very often resembling the males in colour. The coloration is also far from constant, being deepest, as usual, during the spawning-season, and being further subject to sudden changes in accordance with the mood of the fish and the colour and light of its surroundings.

Heincke was the first to point out, among the changes of growth, the increase in the number of rays in the first dorsal fin — in one species (*Gobius flavescens*) he found that young specimens had 5 rays in this fin, old specimens 6 or (in most cases) 7 or (exceptionally) 8. In connexion with this circumstance he also points out the individual variations. Out of 208 specimens of this species which he examined, eight had 8 rays in the first dorsal fin, three 6, and the rest 7[c].

The extent of the scaly covering on the anterior part of the body also varies with age, as far as this can be fixed by the size of the specimen. Winther[d] and after him Collett[e] and Lilljeborg[f], believed that the most important specific characters within this genus were to be found in the differences which the species often show in the extent of the naked (scaleless) part of the body. In the small species the scales are wanting on the belly, on the body in front of the ventral and pectoral fins, and also on a strip of the back along the whole base of the first dorsal fin or the anterior part thereof. In the large species of the genus which belong to the Scandinavian fauna, on the other hand, it is a standing rule that the whole body, with the exception of the head, is covered with scales, and sometimes the occiput and the forehead behind the eyes, are also scaly. Heincke has shown that the largest Scandinavian species, *Gobius niger*, during the growth of individual specimens passes through stages of development which, with regard to the extent of the scales, correspond to the adult state of the smaller species. In a specimen 21 mm. in length, he found the head, with the occiput and a narrow strip along the base of the first dorsal fin, as well as the belly between the ventral fins and the vent, entirely bare of scales. Of the fry of the same species Lilljeborg[g] also remarks that "no scales appear on the top of the head or on the occiput." In a male *Gobius niger* from Känsö, in the island-belt of Gothenburg, 67 mm. long, the scales are also wanting both on the throat in front of the ventral fins and on the part of the dorsal edge already referred to. In the same way there are no scales in front of the ventral fins in a *Gobius minutus* 50 mm. long, from the island-belt of Stockholm.

These observations clearly show that neither the variable colour of the body, nor the number of rays in the first dorsal fin, nor even the extent of the scales on the front part of the body may be used as a trustworthy specific character. The definition of the species grounded on the size and number of the scales of the body is often liable to equally great uncertainty. True, the scales on the caudal region are arranged in fairly regular rows; but on the abdominal sides, in front of the second dorsal fin, they generally become smaller and smaller, and their arrangement more and more irregular, the nearer they are to the front part of the body. This sometimes renders it a matter of some difficulty to compute the number of scales in a line along the sides of the body. In the following table, by which it should be possible to recognise the species which have hitherto been established and adopted as belonging to the Scandinavian fauna, and which is also intended to show their natural relationship, we have endeavoured, as far as possible, to avoid the employment of such characters as may easily lead astray. However, as we shall now show, the question of the actual right of all these species to recognition is still unsolved. Several of them are founded on an insignificant number of known specimens, and the variations of such "species" are far too little known to admit of their elucidation on scientific principles.

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[a] Skand. Naturf. Mode Kbhvn 1873, Beretn., p. 382.

[b] Arch. f. Naturg., 46:ter Jahrg. (1880) Bd. I, pp. 304 etc.

[c] According to Canestrini (Arch. Zool. Anat. Fis., Genova 1861, vol. I, fasc., II, p. 125), the number of rays in the first dorsal fin of *Gobius guttatus* also varies between 6 and 7.

[d] Naturh. Tidskr., Kbhvn, ser. 3, vol. IX (1874), pp. 197 etc.

[e] Christ. Vid. Selsk. Forh. 1874, pp. 153 etc.

[f] *Sv., Norg. Fisk.*, I, pp. 563 etc.

[g] L. c., p. 570.

A: Length of the peduncle of the tail at the upper margin[a] about $^1/_2$ that of the base of the second dorsal fin. Least depth of the tail more than 30 % of the length of the head. Six rays in the first dorsal fin. Vent situated in front of the middle of the body.

a: Number of scales in a transverse row on the body at the beginning of the anal fin about 12, and in a row along the sides of the body about 40....... *Gobius niger.*

b: Number of scales in a transverse row on the body at the beginning of the anal fin about 7, and in a row along the sides of the body about 25....... *Gobius Friesii.*

B: Length of the peduncle of the tail at the upper margin about equal to the base of the second dorsal fin.

a: Least depth of the tail more than 30 % of the length of the head or than 40 % of the length of the peduncle of the tail at the upper margin.

aa: Number of scales in a transverse row on the body at the beginning of the anal fin about 10—12, and in a row along the sides of the body about 40. Vent situated in front of the middle of the body.

α: Seven rays in the first dorsal fin *Gobius flavescens.*

β: Six (exceptionally five) rays in the first dorsal fin.

αα: Longitudinal diameter of the eye less than $^2/_5$ of the distance from the first ray in the first dorsal fin to the first ray in the second... *Gobius microps.*

ββ: Longitudinal diameter of the eye more than $^2/_5$ of the distance from the first ray in the first dorsal fin to the first ray in the second *Gobius pictus.*

bb: Number of scales in a transverse row on the body at the beginning of the anal fin about 6—8, and in a row along the sides of the body 25—30.

α: Seven rays in the first dorsal fin. Vent situated in front of the middle of the body....... *Gobius orca.*

β: Six (exceptionally five) rays in the first dorsal fin.

αα: Vent situated behind the middle of the body .... *Gobius scorpioides.*

ββ: Vent situated in front of the middle of the body.. *Gobius Jeffreysii.*

b: Least depth of the tail less than 30 % of the length of the head or than 40 % of the length of the peduncle of the tail at the upper margin. Number of scales in a transverse row on the body at the beginning of the anal fin about 12—14, and in a row along the sides of the body about 60. Six (exceptionally five) or seven rays in the first dorsal fin. Longitudinal diameter of the eye less than $^1/_3$ of the distance from the first ray in the first dorsal fin to the first ray in the second. Vent situated in front of the middle of the body... *Gobius minutus.*

Among these recognised species we have first to distinguish the deep-water forms, with larger eyes, larger (more scattered) scales and more elongated (low) body. To this division belong *Gobius Friesii*, *orca*, *scorpioides* and *Jeffreysii*, the last three of which we have been able to examine only in one solitary specimen the name of which could be fixed with certainty. With this exception, these four species are given here on the authority of other writers. We would also mention here that the distinction between *Gobius microps* and *Gobius pictus* has in many respects proved difficult to fix. Remembering the account we have given above of the variation in the number of the rays in the first dorsal fin, we consider it by no means improbable that future researches may show the connexion between these forms to be so close that the Scandinavian fauna at the present time really contains only five known species of the genus, precisely those which, as early as 1838, were adopted by FRIES, together with *Gobius Jeffreysii*, a species which has been described at a later date. Perhaps, however, we may be compelled rather to return to NILSSON's point of view in his *Prodromus*, where he refers *Gobius flavescens* and *Gob. minutus* to one species, an opinion which would now involve the regarding of all the last seven "species" in the above table as varieties of one and the same species.

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[a] Between the second dorsal and the caudal fins.

THE BLACK GOBY (SW. SVARTA SMÖRBULTEN).

GOBIUS NIGER.

Plate XIII, figs. 3—5.

Second dorsal fin long, the length of its base being at least equal to $^4/_5$ of the distance between the first dorsal fin and the tip of the snout. Peduncle of the tail deep and short; its least depth in full-grown specimens more than $^3/_5$ of the distance between the first rays in the two dorsal fins, and its length from the end of the base of the second dorsal fin to the first upper supporting ray of the caudal fin at most about 40—45 % of the base of the second dorsal fin. Longitudinal diameter of the eye in full-grown specimens less, or at most only slightly more, than $^1/_4$ of the length of the head. Caudal fin rounded at the end. The two dorsal fins set fairly close together, sometimes united at the base. Scales middle-sized, about 40 in a row along the sides of the body, and about 12 in a transverse row between the beginning of the anal fin and the second dorsal fin. Scales of the front part of the body extending forward, in full-grown specimens, along the dorsal side to a point vertically above the hind margin of the eye, and on the abdominal side to a point vertically below the union of the branchiostegal membranes and the isthmus. Body marked with indistinct, black, transverse bands on a brownish green or dark grayish green ground.

$R.\ br.\ 5;\ D.\ 6\,\frac{1}{11-13};\ A.\ \frac{1}{10-12};\ P.\ 17-19;\ V.\ {}^1/_5;$
$C.\ x+13(15)+x.$

Syn. *Gobius* vel *Gobio* (*marinus*) *niger*, (SALV.), BELON, RONDEL., GESN., WILLUGHBY, SCHONEV., vide ART., *Gen. Pisc.*, p. 28; *Syn. Pisc.*, p. 46.

Gobius niger, LIN., *Syst. Nat.*, ed. X, tom. I, p. 262; MÜLL., *Zool. Dan. Prodr.*, p. 44; RETZ., *Fn. Suec. Lin.*, p. 326; NILSS., *Prodr. Ichth. Scand.*, p. 93; EKSTR., Vet.-Akad. Handl. 1834, p. 60; FR., ibid. 1838, p. 242; KR., *Danm. Fiske*, I, p. 382; EKSTR., *Skand. Fisk.*, ed. 1, p. 157; WRIGHT, ibid., tab. 36; NILSS., *Skand. Fauna, Fisk.*, p. 219; SUNDEV., Stockh. Läns Hush. Sällsk. Handl. VI (1855), p. 80; GTHR, *Cat. Brit. Mus., Fish.*, III, p. 11; MGRN, *Finl. Fisk.* (disp.) p. 16; LINDSTR., *Gotl. Fisk.* (Gotl. Läns Hush. Sällsk. Årsber. 1866) p. 15 (sep.); WINTH., Naturh. Tidskr. Kbhvn, ser. 3, vol. IX, p. 181, tab. VII et pp. 198 et 224; vol. XI, p. 54; vol. XII, p. 16; COLL., Chrnia Vid. Selsk. Forh. 1874, p. 153; ibid., Tillægsh., p. 52; CEDERSTR., Öfvers. Vet.-Akad. Förh. 1876, N:r 4, p.65; MALM, *Gbgs, Boh. Fn.*, p. 423, tab. V, fig. 1; FEDDERSEN, Naturh. Tidskr. Kbhvn, ser. 3, vol. XII, p. 74; HEINCKE, Arch. f. Naturg., Jahrg. 46 (1880), 1, p. 306; MOR., *Hist. Nat. Poiss., Fr.*, vol. II, p. 230; DAY, *Fish. G:t Brit., Irel.*, I, p. 163, tab. LII, fig. 3; MELA, *Vert. Fenn.*, p. 283, tab. IX; MÖB., HCKE, *Fische d. Osts.*, p. 52; LILLJ., *Sv., Norg. Fisk.*, I, p. 564;

Gobius jozo, MÜLL., *Zool. Dan. Prodr.*, p. 44; RETZ., *Fn. Suec. Lin.*, p. 326.

In the Baltic the Black Goby seldom exceeds a length of 75 mm., but in the North Sea it attains a length, measured from the tip of the snout to the base of the caudal fin, of fully 150 mm. The body is elongated, anteriorly almost terete and from the vent to the caudal fin compressed. The greatest depth, generally at the beginning of the first dorsal fin, is about $^1/_6$ of the total length of the body; and the greatest thickness, generally at the operculum, often equal to and in other cases only slightly less than the depth. The least depth of the body (tail) is about $^1/_{10}$ (in young specimens about $^1/_{11}$) of the length. The back is broad and convex, the belly flat; the curves of the dorsal and ventral profiles about equal. The head is fairly large, measuring slightly less than $^1/_4$ of the length of the body, convex at the top, with a depression between the eyes, and flat underneath. The length of the perpendicular drawn through the eye is $^1/_2$ the length of the head. The cheeks are so tumid that the breadth (thickness) of the head across them is $^3/_4$ of its length. The occiput is also tumid, with a longitudinal groove which ends at the beginning of the first dorsal fin, in the middle. The mouth is fairly large and turned somewhat upwards; the length of the lower jaw is about 43 %[a] of that of the head. The jaws project about equally far; they are surrounded by a thick skin in the form of a round lip, and are armed with short, pointed teeth, set in several irregular rows. In the outermost row the teeth are longer, but farther apart, and subulate with recurved points. The palate is smooth (toothless), like the tongue, which is thick, with truncate tip. The pharyngeal teeth, two patches above and one below, are small and conical. The gill-openings are fairly small. The four branchial arches have two rows of tubercles on the anterior side. The gill-cover, as well as the cheeks, is scaleless. The preopercular margin, in which the pores mentioned above are situated, forms a fairly even curve, with rounded corner. The operculum has a row of papillæ along the base and another obliquely across the middle of its surface, and together with the suboperculum forms a triangle, the upper posterior corner of which is pointed, but hidden in a dermal flap which closely unites it to the body. The branchiostegal membrane is fastened to the isthmus on each side, from a point exactly in front of the lower end of the base of the pectoral fin. The rows of papillæ on the cheeks are arranged both longitudinally and transversely, being somewhat different in different individuals, but essentially as shown in fig. 63, borrowed from Winther. The eyes are moderately large in full-grown specimens, measuring from 22 to 25 % of the length of the head, somewhat oblong and prominent: in young specimens they are relatively larger, at a length of 34 mm. measuring 31 % of the length of the head. They are also far apart in adult specimens, the distance between them being about equal to their vertical diameter; but in young specimens the breadth of the interorbital space is hardly more than $^1/_2$ the diameter of the eye. They are set so high that they are not touched by the line drawn from the anterior margin of the upper jaw to the middle of the caudal fin. In the forehead between the eyes there are two pores (see fig. 63), the anterior broad and set transversely, the posterior smaller and round; and behind the middle of the posterior margin of each eye is another pore. All these pores belong to the system of the lateral line. The nostrils are double, small and indistinct, the anterior pair being tubular, and the posterior small round holes just in front of the eyes. Nearer the middle of the head than the latter, on each side of the snout, is a large pore, belonging to the system of the lateral line.

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[a] In young specimens the lower jaw is relatively longer. In a specimen 34 mm. long we found the length of the lower jaw to be 45 % of that of the head.

The front part of the body, on the top of the head behind the eyes and on the anterior part of the back, is covered with small, cycloid scales; but on the greater portion of the remainder of the body the scales are ctenoid, striate and imbricate, broad in proportion to their length, and at the hind margin dentated with fine bristles, which render the body rough to the touch, when the thick mucus which covers it, has been removed. The scales are firmly fixed, and are largest in the middle line of the sides, which contains from about 36 to 40 scales. The true lateral line is wanting, no perforated scales appearing in it; but each or each alternate scale in the middle line, at least on the anterior part of the body, is furnished with a transverse row of small papillæ belonging to the system of the lateral line, and set just behind the posterior margin of the next scale in front (see fig. 63).

Close behind the vent, which lies in front of the middle of the body, is a soft genital papilla, longer and more pointed in the male than in the female.

The two dorsal fins are set close together, especially in the male. The anterior begins at a distance from the tip of the snout equal to 26 or 27 % of the length of the body, vertically above the end of the insertion of the pectoral fins, and terminates vertically above the vent. The anterior corner of this fin is rounded, the posterior projects in a point, and the upper margin is straight, this shape being due to the fact that the first five rays are much longer than the fin-membrane, but in spite of this lie within it in a curve, one behind another. When the thin and fragile fin-membrane is carelessly handled, the rays break loose, and then project considerably above the membrane, thus giving the fin a rounded shape, with the tips of the rays free (*Gobius jozo*). This fin contains six rays, the middle ones being the longest, and the sixth being farther apart from the next one than is the case with the other rays. The distance between the beginning of the first dorsal fin and that of the second is from 15 to 17 % of the length of the body. The posterior dorsal fin, the base of which measures from 23 to 29 % of the length of the body, begins above the vent and ends behind the perpendicular from the end of the base of the anal fin. In the females and young males it is generally of fairly uniform height, or even, in the former, lower posteriorly; but in the adult males and sometimes in the females, the posterior corner is so high or elongated that the last rays, when depressed, extend over the base of the caudal fin. The anterior corner is rounded. The number of rays in this fin is 13 or 14, generally 13, in which case, however, the last ray is divided down to the base. The pectoral fins are rounded and contain from 17 to 19 branched rays, generally the former number; the middle rays are the longest. The ventral fins, which are inserted below the pectoral, are united into a cucullate (cornet-like) shape, and with this exception normal, each containing one simple ray and five rays branched to the base. The anal fin, which begins at a distance from the tip of the snout equal to from 46 to $49\,^{1}/_{2}$ % of the length of the body, and the base of which measures from 17 to 20 % of the length of the body, is of the same shape as the second dorsal fin, and contains 12 or 13 rays, generally the former number, the first ray being simple, and the others branched at the tip, with the exception of the last, which is branched to the very base, at least when there are only 12 rays. The caudal fin contains 14 or 15 branched rays, generally the latter number; but one or, in most cases two, those at the extreme margin of the fin, are so short that they are most correctly regarded as branched supporting rays. The length of the middle rays of this fin, in young specimens, is about 19 %, sometimes nearly 20 %, of the length of the body, in old about 16 %.

The upper part of the body is greenish black, with darker, broad, transverse spots on the sides. Along the middle of the sides there are a few, scattered, black spots. Occiput grayish brown; cheeks, snout and forehead black. Belly grayish white. Anterior dorsal fin yellowish gray, with darker, wavy, transverse streaks; pectoral fins grayish brown. Posterior dorsal and anal fins greenish black, with darker margin, and the former marked with black spots, arranged in rows. Caudal fin dark grayish brown. Ventral fins yellowish white, but often, in the males, with black streaks or dots along the rays. Young specimens are always lighter in colour than old ones. The colour also changes quickly after the fish has been drawn out of the water, and then acquires a reddish tint.

The liver is yellow, and so large that it fills about $^{3}/_{5}$ of the left side of the abdominal cavity. It is also almost undivided, only having two incisions in the right margin. The gall-bladder is small and white. The digestive canal is about $^{1}/_{6}$ longer than the body, and fairly wide throughout its length; anteriorly it is somewhat widened to form the stomach. It forms two bends, one at the end of the abdominal cavity and another just behind the stomach, where the small spleen is also situated. The air-bladder is clear and almost round; the urinary bladder long and narrow. The testes and ovaries are described above. The spinal column is composed of 28 vertebræ, 11 of which belong to the abdominal region.

In Scandinavia, in places of a suitable nature, the Black Goby is a fairly common fish, both on the west coast and in the Baltic, where, however, it becomes rarer northwards, only seldom occurring in Ålands Haf and the Gulf of Finland. Where the coast is sandy, however, and the vegetation scanty, it does not thrive. It is thus wanting, or at least rare, on the south and east coasts of Scania and the south coast of Halland. It apparently prefers water of a moderate depth, where the bottom is stony; and at spots of this nature it is common during the summer-months, but at the approach of winter it retires into deep water, though even at this season it is sometimes taken by tackle set for other fishes. On the coast of Norway its range extends at least as far north as Trondhjem Fjord. In the Orkneys, Great Britain and Ireland, and in the Channel, it is common; but whether it occurs farther south, is still an open question. According to VALENCIENNES[a] and STEINDACHNER[b] it does not occur in the Mediterranean, but according to CANESTRINI[c] and MOREAU (l. c.) it is even common there. These contradictory statements are due to the want of certainty in the determination of the species within this genus.

The Black Goby is apparently of sluggish temperament, and its movements in the water are far from active. Its food is composed chiefly of crustaceans and worms, but it also eats vegetable substances. The spawning-season occurs during the summer-months, beginning in May, and the roe is deposited on stones or dead shell-fish. "The Black Goby," says SAVILLE-KENT[d], "is frequently met with beneath large stones at low water, it selecting such a habitat not only as an ordinary domicile, but as a nursery where it may safely deposit and hatch its spawn. The eggs[e], as frequently observed by the writer, are of very singular shape, being elongate, ovate or fusiform, about three times as long as broad, and are attached vertically by one of the smaller ends in a single, closely approximated layer, that may extend over an area of many square inches of the under surface of the rock selected. Over these eggs the male fish now mounts guard, vigorously repelling all would-be intruders with whom he can cope on equal terms, and in those instances in which the disturbing influences are apparently too strong for him — such as human interference — resorting, in self-defence, to an artful stratagem. On several occasions, when shore-collecting in the Channel Islands, the writer has, in fact, on turning the rocks over in search of specimens, dislodged what at first sight, from the apparently large size of its head, was taken for a Bullhead (*Cottus*) but on closer examination proved to be an example of the Rock Goby, with its opercula and branchiostegal membranes abnormally distended, with the evident intention of passing itself off as one of those spiny-headed *Cottidæ* which are not to be handled with impunity. A like imitation of a hurtful or stronger form is adopted, as a means of protection, by harmless and weaker species in many departments of the Animal Kingdom."

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[a] CUV., VAL., *Hist. Nat. Poiss.*, vol. XII, p. 19.

[b] Stzber. Akad. Wiss. Wien, LVII (1868), I, p. 413.

[c] Arch. Zool., Anat. Fis., Genova 1861, vol. I, p. 135.

[d] *Brit. Mar. Freshw. Fish.*, Handb. Gt. Intern. Fish. Exhib. London 1883.

[e] See above, p. 242.

No special fishery is carried on and no special tackle used for this fish. It is taken only by accident among other fishes. In Sweden the flesh, though its flavour is not disagreeable, is not used for human food, but is thrown away with other refuse as food for domestic animals. (Ekström, Smitt.)

GOBIUS FRIESII.

(Fig. 65.)

Second dorsal fin long, the length of its base being about equal to the distance between the first dorsal fin and the tip of the snout. Peduncle of the tail short, but relatively low, its least depth being less than $^1/_2$ the distance between the first rays in the first and second dorsal fins, and its length from the end of the base of the second dorsal fin to the first upper, supporting ray of the caudal fin about $^1/_3$ of the base of the second dorsal fin. Longitudinal diameter of the eye more than $^1/_4$ of the length of the head. Caudal fin pointed. The two dorsal fins well separated. Scales large, about 25 in a row along the sides of the body, and about 6 in a transverse row between the beginning of the anal fin and the second dorsal fin. In the front part of the body the scales extend along the dorsal side to the posterior margin of the eyes, which are set very close together, and on the abdominal side to a line with the point of union of the branchiostegal membranes to the isthmus. Body marked with golden or red or darker-coloured spots on a yellowish brown ground.

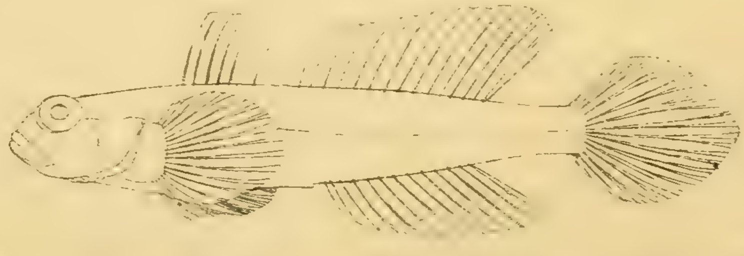

Fig. 65. *Gobius Friesii*, from Gullmar Fjord, 5th Jan., 1838. Natural size. After v. Wright's figure in Fries.

$R.\ br.\ 5: D.\ 6\,\frac{1}{14^a}: A.\ \frac{1}{13^b}; P.\ 18\ \text{l.}\ 19; V.\ ^1/_5: C.\ x+13(14)+x.$

Syn. *Gobius gracilis*, Fr., Vet.-Akad. Handl, 1838, p. 245, tab. IV, fig. 2; Nilss., *Skand. Fn., Fisk.*, p. 224.

Gobius cruentatus, Gthr (nec Lin.), *Cat. Brit. Mus., Fish.*, vol. III, p. 54 (in synon.).

Gobius Friesii, Malm, Skand. Naturf. Möde, Kbhvn 1873, Ber., p. 383; Coll., Christ. Vid. Selsk. Forh. 1874, p. 154; Malm, *Gbgs, Boh. Fn.*, p. 425, Lillj., *Sv., Norg. Fiskar*, I, p. 573.

This Goby is one of the least-known species within the genus, if indeed it do not finally prove, as Collett suspected, to be identical with a Mediterranean and somewhat better known species, *Gobius Lesueurii*[c]. The extent of the scales on the head in *Gobius Friesii*, and

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[a] According to Collett, 13.

,, ,, ,, 12.

[c] Risso, *Hist. Nat. Princ. Prod. Eur. Mér.*, Tome III, p. 284; Cuv., Val., *Hist. Nat. Poiss.*, vol. XII, p. 33; Canestrini, Arch. Zool., Anat., Fis., Genova 1861, vol. I, p. 143, tab. VIII, fig. 2.

the number of the branchiostegal rays, stated at 4, in *Gob. Lesueurii*, are apparently the only characters that distinguish these forms[a].

Compared with the body of the Black Goby, that of *Gobius Friesii* is more elongated and shows stronger lateral compression. The greatest depth of the body is between $^1/_6$ and $^1/_7$ of the length thereof[b], and the greatest thickness, across the base of the opercula, is only $^5/_7$ of the former. The least depth in our specimens, which are from 91 to 95 mm. long, is between $^1/_{14}$ and $^1/_{15}$ of the length. The length of the head is about $^1/_5$ of that of the body. The occiput is flat and without any middle groove, but relatively narrow. The eyes are very close together at the top, being separated only by a narrow, bony strip of the forehead. Their longitudinal diameter is $^1/_3$ of the length of the head[c]. The mouth is turned somewhat sharply upwards, and the length of the lower jaw is 48 % of that of the head. The lower jaw also projects distinctly beyond the tip of the upper jaw.

The dermal papillæ on the head which belong to the system of the lateral line, are large and prominent, according to Collett[d]. They seem to be arranged essentially in the same way as in the preceding species. On the cheeks below the eye four, almost parallel lines run back from the region behind the nostrils; and the two lines on the under surface of the lower jaw bend upwards along the hind margin of the preoperculum, where they extend even farther up than in the preceding species. There is also a perpendicular row along the base of the operculum. This row contains 20 papillæ, and from the twelfth, counting from the top, runs the horizontal row to the hind margin of the operculum. On each side of the snout there are two parallel rows in a backward direction from the posterior nostril; but these rows unite between the eyes, and then form two rows, diverging from each other, on the top of the head. There are also two parallel rows in a backward direction from the hind margin of each eye; and, lastly, there are short, vertical rows just above the insertion of the pectoral fins.

The scales on the top of the head behind the eyes are ctenoid and those on the front part of the back are almost as large as those on the upper part of the body, which are distinguished from the scales of the preceding species by their greater breadth, the greater number of their fan-like striæ and the weaker bristles at their hind margin. These scales are deciduous. Their number in a transverse row upwards from the beginning of the anal fin is 6, and, according to Collett, in a row along the sides of the body about 25.

In this species too, the anal papilla is well-developed.

The two dorsal fins are distinctly separated, even in the male. The distance between the anterior dorsal fin and the tip of the snout is from 25 to $26^1/_2$ % of the length of the body. In this fin are 6 rays, the first five being of fairly uniform length (in the female?) or, as in one of our two specimens[e], the first of all being prolonged into a filament and of about the same length as the head. The distance between the beginning of the first dorsal fin and that of the second is 16 or 17 % of the length of the body. The base of the latter fin measures from about 26 to $27^1/_2$ % of the length of the body, and the base of the anal fin from 18 to 20 % thereof. The mutual position of these fins, as well as their position with regard to the rest of the body, is the same as in the preceding species. In other respects the figure, drawn by v. Wright with his well-known accuracy, shows the form and relative size of these fins as well as of the others; but the small, anterior, supporting rays at the top and bottom of the caudal fin are not represented in the figure, and the peduncle of the tail thus seems longer than it is in reality — in both of our specimens it measures only 9·1 % of the length of the body. The number of the simple, supporting rays of the caudal fin is 7 above and 6 below; while in Fries's specimen there are 14 branched rays — one above and two below, however, being exceedingly short — and in our second specimen 13.

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[a] "Il capo e perfettamente privo di squame", says Canestrini of *Gob. Lesueurii*. Cf. also Lilljeborg (l. c.), in whose male specimens, however, the third ray of the first dorsal fin was elongated, in place of the hair-like elongation of the first ray of this fin in *Gob. Lesueurii*, according to Canestrini, and in one of our two specimens of *Gob. Friesii*.

[b] In young specimens the depth is relatively greater than in old, to judge by Collett's specimen, which was 59 mm. long and 10 mm. deep, while Fries's specimen was 95 mm. long and 14 mm. deep.

[c] This is true both of Fries's and Collett's specimens; but in a specimen from Strömstad, sent by Mr. C. A. Hansson, the longitudinal diameter of the eye is only slightly more than $^1/_4$ ($27^1/_2$ %) of the length of the head.

[d] In our specimens, in which the epidermis is almost entirely destroyed, they are scarcely visible.

[e] This specimen, which was taken out of the gullet of a Cod, though the belly round the vent is damaged, is undoubtedly a male, as it was possible to extract portions of the testes through the wound thus caused. On the other hand, I have refrained from destroying Fries's specimen, which, to judge by the small size of the anal papilla, is probably a female, in order to decide the question of sex.

The coloration of this species has been described by FRIES as follows. The only specimen he ever saw, had then been dead far too long to give any certain indications of its colouring during life. Judging by the traces thereof which still remained, he was of opinion that it must be one of the most handsomely marked species. A row of golden spots on a yellowish brown ground still appeared along the middle of the sides, and similar spots followed the rays of both dorsal fins and of the upper half of the caudal fin. The tip of the anal fin was tinged with a darker shade, and the ventral fins, which are still blacker in our other specimen, were almost inky. According to COLLETT, the spots on the sides of the body and the back are darker, and there are no true spots or transverse bands on the fins.

For a long period only one example of this species was known. This was taken in "the large Herring-seines", "in the deep water of Gullmar Fjord" off Lysekil, on the 5th of January, 1838; and the specimen, which has now entirely lost both colour and scales, is still preserved in the Royal Zoological Museum. At a later date, according to COLLETT, Prof. G. O. SARS obtained another specimen, 59 mm. long, in a dredge, in Christiania Fjord. The third specimen that has yet been found, was taken by Mr. C. A. HANSSON, who has done so much for the investigation of the fauna of Bohuslän, "from the throat of a Cod," in Strömstad Fjord, on the 1st of July, 1881. As we have remarked above, this example, which is unfortunately damaged, differs in one or two respects from FRIES's type-specimen; and so far as I can judge, corresponds in every particular, with the exception of the scales on the head[a], to CANESTRINI's *Gobius Lesueurii.*

Our knowledge of this species being so scanty, we have scarcely anything to remark as to its manner of life, save that it is a deep-sea form, which, in the points where it differs from the preceding species, is distinctly analogous to the group of the genus which we are now about to describe.

The following six "species" form a series of intermediate forms between the two preceding species and that given last in the above table, *Gobius minutus.* They are also so closely related to each other that the specific distinction, which is difficult to fix, has always been subject to uncertainty. In the number of the scales they correspond most closely to the two preceding species; and here, as in the latter, we find that those which have been distinguished as deep-water forms, have a smaller number of scales on the body. In conjunction with this peculiarity, the eyes are, as usual, larger in the deep-sea forms; but even among those which live in shallower water, there is a difference in this respect which depends upon a longer or shorter retention of the relatively large eyes as juvenile characters. The same explanation also applies, in my opinion, to the variations in the number of rays in the first dorsal fin. In this respect, as we have mentioned above, we find both changes of growth from a lower to a higher number and individual deviations from the ordinary number. The character given in the above table, on COLLETT's authority, as distinguishing *Gobius scorpioides,* also seems to me to be due to nothing more than an individual deviation. This character too, does not hold good in WINTHER's example of the species, which example in this respect resembles the rest of the Scandinavian Gobies. The elevation of the first dorsal fin which occurs here, as in *Gobius Friesii,* and which, in particular, has given rise to the name of *Gobius orca,* is probably a sexual character belonging to the males, or perhaps appears, as is often the case, as a form-character in certain localities. On this point we are naturally unable to give an opinion with any certainty, for we have not had the opportunity of examining more than one specimen of the last-mentioned, rare "species". Lastly, with respect to the characters based on the coloration, HEINCKE, in his excellent account of the colour-variations in *Gobius flavescens*[b], has warned us most strongly against the definition of the species according to these characters, as they have been given up to the present time.

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[a] It is difficult to count the branchiostegal rays in this specimen, as the branchiostegal membranes are torn. The body is very strongly compressed and anteriorly contorted.

[b] Schr. Naturw. Ver. Schles. Holst., I (1875) pp. 260 etc.

THE DOUBLY-SPOTTED GOBY.

GOBIUS FLAVESCENS.

Plate XIII, figs. 3 and 4.

Second dorsal fin relatively short, the length of its base being at most $^3/_4$ of the distance between the first dorsal fin and the tip of the snout. Peduncle of the tail relatively long and deep, its length at the upper margin being about equal to that of the base of the second dorsal fin, and its least depth more than 7 % of the length of the body, than 30 % of the length of the head or than 40 % of its own length at the upper margin. Eyes, in adult specimens, far apart at the top, and their longitudinal diameter from about 26 to 29 % of the length of the head, or from 36 to 38 % of the distance between the first rays in the first and second dorsal fins. Number of the scales in a transverse row on the body at the beginning of the anal fin between 10 and 12, and in a row along the sides of the body about 40. The dorsal side in front of the first dorsal fin and the middle of the ventral side in front of the anal fin scaleless. Seven rays in the first dorsal fin. Upper part of the body a more or less greenish, blackish brown, with several more or less distinct, light, transverse patches on the back; the sides marked with a row of more or less lustrous, dark spots, one at the middle of the base of the caudal fin and (in the male) another behind the base of the pectoral fin being the most prominent; the ventral side light with a yellowish lustre. Dorsal and caudal fins marked with alternate, dark (red) and light (yellow) stripes, composed of spots. Anal, pectoral and ventral fins for the most part colourless.

R. br. 3 (4); *D.* $7 \left| \frac{1}{9-11} \right.$; *A.* $\frac{1}{10-11}$; *P.* 17 l. 18; *V.* $^1/_5$;
C. $x + 11$ (13)[a] $+ x$; *L. lat.* circ. 35—40.

Syn. *Gobius flavescens*, FABR., *Reise n. Norw.* (1779), p. 322.
Gobius Ruuthensparri, EUPHRASÉN, *Trangrums-Acten*, p. 52; Vet.-Akad. Handl. 1786, p. 64, tab. III, fig. 1; RETZ., *Fn. Suec. Lin.*, p. 326; CUV., VAL., *Hist. Nat. Poiss.*. vol. XII, p. 48; FR., Vet.-Akad. Handl. 1838, p. 243; KR., *Danm. Fiske*, vol. I, p. 399; YARR., *Hist. Brit. Fish.*, ed. II, vol. I, p. 285; NILSS., *Skand. Fn., Fisk.*, p. 226; GTHR, *Cat. Brit. Mus., Fish.*, vol. III, p. 76; LINDSTR., Gotl. Läns Hush. Sällsk. Årsber. 1866, p. 15 (sep.); WINTH., Naturh. Tidskr. Kbhvn, ser III, vol. IX, pp. 199 et 221; ibid., vol. XI, p. 55; ibid., vol. XII, p. 17; COLL., Vid. Selsk. Forh. Christ. 1874, p. 179; ibid., Tillægsh., p. 58; HCKE, Schr. Naturw. Ver. Schlesw. Holst. 1875, l. c.; ID., Arch. Naturg., Jahrg. 46 (1880), I, p. 310, tab. XVI, fig. 5; MALM, *Gbgs, Boh. Fn.*, p. 434, tab. VI, fig. 1; DAY, *Fish. G:t Brit., Irel.*, vol. I, p. 160, tab. LII, fig. 1; MÖB., HCKE, *Fische d. Osts.*, p. 55; LILLJ., *Sv., Norg. Fisk.*, vol. I, p. 609.
Gobius minutus, NILSS., *Prodr. Ichth. Scand.*, p. 94.
Gobius bipunctatus, YARR., *Hist. Brit. Fish.*, ed. I, vol. I, p. 255.

Obs. As FABRICIUS's description of this species — "macula caudali utrinque atra. Pinna D. 7. 12" — is quite as clear as EUPHRASÉN'S remarks thereon, which were first published in 1784 in the Swedish "*Trangrums-Acten*", the current rules of nomenclature require that the name given the species by FABRICIUS should be restored, though it has been generally known for a long period by that of *Gobius Ruuthensparri*.

According to FRIES (l. c.) it is "without doubt this species in particular that bears the name of *Aat* (food) on the coast of Norway", "being so called," writes STRÖM (*Söndm. Beskr.*, p. 266), "because it is eaten by other fishes." MÜLLER (*Prodr. Zool. Dan.*, p. 44) applies this passage in STRÖM to *Gobius Aphya*, which KRØYER (l. c.) therefore gives among the doubtful synonyms of the Doubly-Spotted Goby. The *Aat* which is given among the Gobies by STRÖM, with a reference to ARTEDI'S *Gobius Aphya*, is, however, described as being transparent, and may with equal justice be regarded as a *Gobius minutus* or an *Aphya minuta*.

The greatest length attained by the Doubly-Spotted Goby is between 60 and 65 mm. The greatest depth of the body is about 16 or 17 % (in gravid females about 20 %) of the length thereof. The length of the head is from $21^1/_2$ to $23^1/_2$ %, and its greatest breadth (thickness) about 12 or 13 %, of the length of the body. The least depth of the tail is 7 or 8 % of the length of the body. The other point in the external form of the body which distinguishes this species of the genus, as well as the following ones, from the preceding, is the circumstance that the first dorsal fin begins somewhat farther back, the distance between it and the beginning of the snout being apparently never less than 28 % of the length of the body. The last ray in the first dorsal fin is, as usual, farther apart from the next ray than is the case with the others. There is a distinct interval, without fin-membrane, the length of which corresponds to the width of two or three transverse rows of scales, between the two dorsal fins. In this species, as in the following one, we often find that the distance between the beginning of the first dorsal fin and that of the second is equal to the length of the base of the latter fin, or to the distance between this fin and the first upper, supporting ray of the caudal fin; or also exactly twice the least depth of the tail. The base of the anal fin is generally somewhat shorter, though often only very slightly[a], than that of the second dorsal fin. The length of the caudal fin, which may be rounded, truncate with rounded corners, or even somewhat forked, is generally equal to the base of the anal fin, varying between 14 and 16 %[b] of the length of the body. The distance between the beginning of the anal fin and the tip of the snout is 46 or 47 % of the length of the body. The tip of the ventral fins, which are generally longer in the male than in the female, usually extends to the vent or even beyond it. The length of the rounded pectoral fins is between $^1/_6$ and $^1/_5$ of that of the body. The longitudinal diameter of the eye varies between 6 and 7 % of the length of the body, being comparatively greater, as usual, in young specimens. The interorbital space, which is somewhat depressed in the middle, is externally fairly broad in adult specimens, its breadth being equal to the horizontal diameter of the eye or somewhat greater. It is chiefly formed, however, by the upper dermal covering of the eyes, the breadth of the frontal bones between the eyes being at most equal to the diameter of the pupil. As a result of this, in young specimens or in examples with thin or shrivelled skin, the eyes seem fairly close together at the top. The gape is turned slightly upwards, and the length of the lower jaw, the point of which projects somewhat beyond the tip of the snout, is about 9 % of the length of the body, or from 40 to 44 % of that of the head.

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[a] 15, according to WINTHER.

The Doubly-Spotted Goby is one of the most handsome Scandinavian fishes; and as we are here able to refer to the figures of v. WRIGHT and THORNAM, the latter coloured under the supervision of the late Professor MALM, we leave to HEINCKE[c] the further description of the beauty and the sudden variations of its colouring. He begins with a description of the male in its spawning-dress.

"At the first glance we observe a deep velvet-black spot at the base of the caudal fin surrounded by a pretty golden, marginal ring. This spot is characteristic of the species, and appears in both sexes, but even during the spawning-season is less handsome in the female than in the male. Another black spot, without the golden margin, lies on each side of the body, behind the base of the pectoral fin; but this spot appears only in the male, and is one of the most important external sexual characters. In the female it is generally entirely wanting, though there are sometimes faint traces of it. In the male during the spawning-season the upper part of the body is of a dark brownish-black ground-colour, often shading into green, on the head lighter, with a dash of red and a dull coppery lustre, on the back marked with five selliform, light spots with a dull metallic lustre, which are always set at fixed points, and which give the fish a singular appearance. The several spots are united at the middle of the back, at the base of the two dorsal fins, by narrow, irregular streaks of the same tint. The dark colour of the back extends somewhat below the middle of the sides, but from this point the belly is of an unvaried, light colour with a coppery lustre, as well as the tail, the lower part of which is, however, stained with a black pigment, while the under surface of the head is of a deep copper colour with a golden lustre. The transparent branchial lamellæ render the branchial region blood-red. At the boundary between the light colour of the belly and the dark tint of the back, a little below the middle of the sides, is a row of spots with a shifting, gemmeous lustre of blue and green. A similar spot appears at the upper corner of the operculum.

"The fins of the male, with the exception of the ventral and pectoral fins, which display only a dull lustre here and there, are by no means less brilliant in colour. The anal fin, the remainder of which is almost colourless, is marked with a dark, black streak along the base, a peculiarity which, however, appears with varying distinctness in the males of all our Gobies. The caudal fin, behind the black, gold-edged spot, is adorned with somewhat imperfect, vertical stripes of a varying cherry and yellow colour, which posteriorly become fainter and finally disappear. On each of the dorsal fins there are three horizontal, deep cherry stripes, separated by streaks which appear now of a deeper or fainter yellow, now green.

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[a] According to KROYER, it is sometimes longer than the latter.

[b] According to KROYER, as much as 17 %.

[c] Schr. Schl. Holst., l. c.

"The pupil has a strange, deep blue lustre. The iris is marked with four copper-brown spots, set obliquely in a cross.

"In the female all these colours, especially the markings of the dorsal fins and the iridescent spots on the sides, are much fainter.

"This description may fail to give more than a feeble idea of the beauty of the fish at a given moment. I say *moment*, for under certain circumstances almost all this brilliancy may more or less suddenly and completely vanish, or only leave traces behind to reappear just as quickly.

"On putting one of these small fishes, while still alive, beneath the microscope, we see that several kinds of variously-coloured chromatophores (pigment-cells) lie scattered in the skin. In old specimens the *black chromatophores* are most numerous, occurring almost everywhere on the body, and thickest on the back, at the base of the caudal fin and behind the base of the pectoral fins, where they form the black spots already mentioned, and along the base of the anal fin in the males. The *yellow* or *greenish-yellow chromatophores* are more numerous than the black in young specimens, but not so in old. They occur on every part of the body, with the exception of the pectoral and ventral fins, and are especially prominent on the unpaired fins, where they form the yellow and yellowish green streaks already mentioned. When contracted, they are yellowish red. The *orange or red chromatophores* are less numerous than the preceding ones. They occur in small numbers on the body and in greater number on the head, but are most numerous on the unpaired fins, where they form the cherry stripes mentioned above. When contracted, their colour varies from reddish brown to black. In the selliform spots, on the top of the head and on the belly are collected *chromatophores*[a] *filled with small disks of a metallic lustre* (*glitter*). In their ordinary, expanded state they are confluent, forming an unbroken network. Most of these chromatophores apparently contain black or yellow pigment in the middle; but perhaps these apparently central collections of pigment really lie only on the outside of the chromatophores — this question is not yet solved.

"The fish has the power of now contracting, and now more or less expanding these different chromatophores in a myriad ways, thus causing the most varying and unexpected arrangement of colours. This alteration in the degree of expansion of the chromatophores seems to proceed without a moment's pause, but unfortunately, in consequence of the restlessness of the fish while under examination, can only very imperfectly be followed by the observer. The cells do not seem to be at perfect rest for a single instant; and the colour of the fish undergoes incessant, more or less sudden, irregular variations.

"If, for example, we completely cover with a small box a specimen taken during the spawning-season and of bright coloration, and keep it thus concealed for two or three minutes, or even only one, on removing the box we find the fish entirely changed. There is now not a trace left of the selliform spots; the whole of the variegated dress has disappeared, and is replaced by a monotonous shade of brownish black or blackish green. But this dark colour changes visibly under the influence of light. We see how the selliform spots reappear in their original places. The upper surface of the head becomes lighter. The contrast between the light colour of the belly and the dark tint of the back increases. After a minute or two the fish is as variegated as before. If, on removing the box, we throw a ray of sunlight on the fish by means of a mirror, this alteration takes place much more rapidly.

"If, instead of covering the fish, we place it in water with a black substratum, it also turns perfectly dark, though only after an interval of some length. The selliform spots again disappear almost entirely. The black pectoral spots and the caudal spot scarcely stand out on the ground-colour. Only the belly remains light, for there the black chromatophores are wanting. If the fish, together with the black substratum, be now put under the microscope, all the black chromatophores are seen to be expanded to the uttermost. Even the parts previously occupied by the selliform spots are now so closely filled with these chromatophores, though here their number is small, that the dull lustre can no longer maintain its usual degree of brilliancy. The pretty network is much less distinct; the central collections of pigment which were previously punctiform, have now increased in extent. But on the body, which is thus almost dark, the emerald spots on the middle of the sides still glitter with undiminished, or, if possible, still greater brilliancy. We now see that these spots are composed of nothing more than chromatophores exactly like those which form the selliform spots, but subjected to extraordinarily strong contraction. It is the immense number of glittering disks that are here collected within a comparatively small space, that gives these spots their iridescent lustre, which, when the chromatophores are expanded and the glittering disks distributed over a larger surface, passes into the dull gleam of the selliform spots, the top of the head and the belly.

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[a] Called *iridocytes* by POUCHET. Cf. below, on the variations of colour in the Flounders (p. 367).

"If we now place our darkened Goby on a light bottom of straw or sulphur yellow, for example, after about an hour the fish is as light as it was dark before, and the selliform spots are invisible. Under the microscope we observe the following peculiarities. The black chromatophores are contracted, the yellow expanded. As the former are far more numerous than the latter, we may sometimes see the yellow bottom of the vessel shine through at certain parts of the body, where only contracted chromatophores occur, especially at the tail. This phenomenon is due to the thinness of the body. In the selliform spots there now appear numerous, yellow, expanded pigment-cells; but in addition to these the network of pale, lustrous colour is sharply marked.

"Let us now move the fish, which is partly of a yellow colour and partly transparent, showing the yellow bottom, over some red substance. Instantaneously it assumes a transparent, reddish tint, and the selliform spots, which were invisible on the yellow bottom, become distinct for a moment. There is no other change in the degree of expansion of the chromatophores than that the yellow, as well as the black, are contracted, though not so strongly; while the few red chromatophores on the upper surface of the body, which previously looked like dots varying from brownish red to black, now begin to form pretty projections and large processes of a reddish brown or cherry colour. The rest of the body is as transparent as before. The selliform spots are visible, as they contain no chromatophores, and therefore stand out on the red colour which shines through from the bottom on which we have placed the fish.

"If we now change the substratum from red to blue and from blue to light green, we see that each time we change the colour, the fish for a moment assumes the corresponding tint, on account of its transparency. Exactly the same results may be obtained by setting a dark fish for a somewhat longer period, on a red, blue or green bottom. The adaptation seems to take place most slowly on a green bottom. If a specimen is kept for some time on a light (white or light-coloured) bottom, even the handsome, lustrous, lateral spots grow pale, evidently on account of the expansion of the chromatophores. Last of all the black caudal spot disappears, the pectoral spot having already vanished. The handsome stripes on the fins gradually fade. The male becomes exactly like the female, and in this dress it is quite impossible to distinguish either of them by the colour from a young *Gobius niger* of the same size that has been kept on a light bottom. But if we take the two species out of their narrow glass vessels and again put them among the plants in a large aquarium, all the characteristic differences of colour between them soon reappear. *Gobius niger* never possesses the selliform spots or either of the caudal and pectoral spots that distinguish *Gobius flavescens*. The faintly lustrous chromatophores, which are also present in the former, are there irregularly sprinkled in small groups over the surface of the body, and, when contracted, form irregularly scattered, small, bright dots, but are never arranged with the same regularity as in *Gobius flavescens*.

"In short, *Gobius flavescens* possesses in a high degree the power of adapting its own colour to that of the bottom with comparative rapidity. If the colour is such that the fish possesses chromatophores with the corresponding pigment, these are expanded. If there are no cells containing the corresponding pigment, all the chromatophores are contracted, and the consequent transparency of the body brings about the same result. The metallic lustre is due to extremely fine, crystalline disks, which are either spread on the exterior of a pigment-cell or completely fill it. These cells perform their function in a manner quite the reverse of that of the monochromatic cells; the stronger the contraction, the brighter is their lustre, and the greater their expansion, the duller they appear.

"The same variations of colour as we have now produced artificially, so to speak, also proceed in an aquarium, if its colour-relations correspond to those of the natural home of the fish. The only difference is that in this case the adaptation takes place in a much more intricate manner, but is always guided by the simple or variegated colours of the surroundings. It is often very hard to discover one of these fishes, when at rest among the water-plants.

"During autumn and winter the colours of the Doubly-Spotted Goby are duller, and the sexual distinction in this respect less marked. Furthermore, different individuals seem to possess the power of changing colour in different degrees. One fish takes twice as long as another, before it acquires a uniform dark or light colour; one retains a colour fairly (though never completely) unchanged for a long time, while another, though on the same bottom and under the same circumstances, seems to undergo an incessant shifting of colour. If we continue the above experiments for a lengthy period of time upon the same fish, the chromatophores become distinctly fainter."

Most of the colour characters given in the above description are, however, not entirely peculiar to the Doubly-Spotted Goby. The selliform spots, in particular, have been described as characteristic of the next two species, especially of *Gobius pictus*, and also occur, as Lilljeborg has already remarked, in *Gobius minutus*, even though some difference may be shown in their prominence and position. The black caudal spot is also common to the following species, though in them it seems never to be so sharply defined; and though the emerald spots on the sides, sometimes sharply separated by a black space between them, have not been observed in the following species, they still have a corresponding marking of black, simple or bisected spots, which sometimes appear like transverse bands. As is shown in v. Wright's figure, there also occur in *Gobius flavescens* two black spots, starting from the eyes down the cheeks and snout, the one ending just behind the corner of the mouth, and the other running almost straight forward. We may hence judge how inconstant are the characters derived from colour; but the black spot, during life with an azure lustre, that occurs at the end of the dorsal fin in the two following species, and which Heincke has given as one of the external sexual characters of the male of *Gobius minutus*, is apparently wanting in *Gobius flavescens*.

The habits of the Doubly-Spotted Goby are no less interesting than its beauty of colour. It is one of the most handsome aquarium fishes and pleasing enough, though its propensity of hiding itself renders it difficult to discover in aquaria which are thickly overgrown with plants. It sustains life without difficulty in fresh water, if gradually accustomed to it; but if suddenly removed from salt water to cold fresh water, it becomes rigid and dies with expanded fins, just as when it is thrown into strong spirit immediately after its capture. Lowe states of this species, according to Day, that it readily learnt to take food from his hand. "Its movements," says Heincke, "are restless and active; and with the funnel-shaped ventral fins it can firmly attach itself even to the perpendicular walls of the aquarium."

In its free state the Doubly-Spotted Goby prefers a rocky bottom, thickly overgrown with seaweed, at a depth of from 1 to 10 fathoms; but it is also found in weedy spots, where the bottom consists of stones or gravel. The Royal Museum possesses several specimens which were taken in a dredge at spots of this nature. Malm, however, as well as Parnell, found it living in quite another manner, more resembling the life of the Sticklebacks. "In contradistinction to all the Gobies," writes Malm, "which in Sweden keep to water so shallow that they may be observed without difficulty, it is only very seldom that this fish is seen near, or, more strictly speaking, at the bottom. I have observed this on only few occasions, and it has then been a solitary, full-grown male that has swum in and rested on a rock; but, on leaving its resting-place, has risen in the water, not creeping, as it were, along the bottom like *Gobius niger*, *microps*, *pictus* and *minutus*. As a rule it is only seen in larger or smaller, close-packed companies, in mid-water, so to speak, and especially at clear spots in the Zostera region. The water may be two or three fathoms deep or more, but the shoal stays, sometimes almost still, a foot or two below the surface. I have often seen shoals containing several hundred small specimens and only one or two full-grown individuals, thus seeming to be composed of a family or two that led an isolated life in this manner. When disturbed, the shoal sinks deeper in the water, but as a rule, soon rises again. I have never succeeded in enticing this fish to take a bait, though I have taken its kindred species in this manner; but when it leaves the bottom, at least in the daytime, it may easily be taken with a hand-net."

The spawning-season occurs in summer, from May to August. The female attaches the eggs to the shells of dead shellfish or Balanids, and the male keeps faithful and courageous guard over them.

The Doubly-Spotted Goby is fairly common on the west coast of Sweden — being called *Röbug* ("Red-belly") in Bohuslän, according to MALM — in the Sound and on the rest of the Danish coast (WINTHER) and in the south of the Baltic (HEINCKE and BENECKE[a]). It has been taken by the eminent naturalist, Dr. KOLMODIN, at Mörbylånga on the coast of Smolandia, by Baron G. C. CEDERSTRÖM on the coast of Gothland, and by Mr. WAHLBERG, Inspector of Fisheries, and Dr. SÖDERLUND in the island-belt of Stockholm; but up to the present time it has not been ound in Finland or the Baltic Provinces of Russia[b]. On the coast of Norway, according to COLLETT, its range extends at least as far as Lat. 65° N. It lives on the coasts of Great Britain and Ireland and on the west coast of France, north of Gascony; but we have no certain evidence of its occurrence farther south or in the Mediterranean.

The Doubly-Spotted Goby is so small that it is of no immediate economical value, but as supplying food to our edible fishes, it is of some importance. Its own food is composed of small crustaceans.

GOBIUS MICROPS.

(SW. LERSTUBBEN[c]).

Plate XIII, fig. 5.

Characters essentially the same as those of the preceding species, but the longitudinal diameter of the eye in full-grown specimens sometimes less than $^1/_4$ of the length of the head and at most 40 % of the distance between the first ray of the first dorsal fin and that of the second. The boundary of the scaly covering of the body on the dorsal side extending from the end of the first dorsal fin along the sides of its base and at a distinct distance therefrom. Rays in the first dorsal fin not more than 6. Colour of the body lighter and less variegated than in the preceding species, but with more brownish (black) spots and transverse bands; among the black spots arranged in rows on the first dorsal fin there sometimes appears a larger spot on the back part of the fin, with a marked, azure lustre.

R. br. 5; *D.* (5) 6 $\frac{1}{9\text{-}10}$; *A.* $\frac{1}{8 \text{ l. } 9}$; *P.* 17 l. 18; *V.* $^1/_5$; *C.* $x+11$ (13 l. 15)$+x$.

Syn. *Gobius microps*, KR., *Danm. Fiske*, vol. I, p. 416; OLSSON, Öfvers. Vet.-Akad. Förh. 1868, p. 475; MALM, ibid. 1870, p. 844; ID., Forh. Skand. Naturf. Möde Kbhvn, 1873, p. 383, cett.; WINTH., Naturh. Tidskr. Kbhvn, ser. 3, vol. IX, pp. 199, 200, cett.; vol. XI, p. 55; vol. XII, p. 17; COLL., Forh. Vid. Selsk. Christ. 1874, p. 168; ibid., Tillægsh., p. 56; N. Mag. Naturv. Christ., Bd. 29 (1884), p. 61; MALM, *Gbgs, Boh. Fn.*, p. 426, tab. V, fig. 2; HANSSON, Öfvers. Vet.-Akad. Förh. 1880, No. 4, p. 20; LILLJ., *Sv., Norg. Fisk.*, vol. I, p. 602; HANSEN, *Zool. Dan.*, *Fiske*, p. 35, tab. VI, figg. 1 et 2.

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[a] *Fische, Fischerei etc. in Ost- und Westpreussen*, pp. 84 and 201.

[b] SEIDLITZ, *Fauna Baltica*, pp. 29 and 121 (Arch. Naturh. Liv-, Ehst- und Kurlands, ser. 2, Bd. VIII, Lief. 1).

[c] A. W. MALM, l. c.

GOBIUS PICTUS.

(SW. BERGSTUBBEN).

Plate XIII, fig. 6.

Characters essentially the same as those of the preceding species, but the longitudinal diameter of the eyes, which approach more or less closely to each other on the forehead, from about 28 to 31 % of the length of the head, and more than 40 % of the distance between the first ray of the first dorsal fin and that of the second; the anterior boundary of the scales on the dorsal side running downwards and forwards from the middle, or from a point nearer the beginning of the first dorsal fin, which contains 6 rays; and the colour of the body brighter and more variegated, with the lateral spots on the body and the selliform dorsal spots more sharply defined.

R. br. 5; *D.* $6\left|\frac{1}{9}\right.$; *A.* $\frac{1}{9}$; *P.* 17 l. 18[a] *V.* $^{1}/_{5}$; *C.* $x+11\,(13)+x$.

Syn. *Gobius pictus*, Malm, Förh. Skand. Naturf. Möte, Sthlm 1863, p. 410; *Gbgs*, *Boh. Fn.*, p. 429, tab. V, fig. 3; Winth., Naturh. Tidskr. Kbhvn, ser. 3, vol. IX, p. 199 et 218; vol. XI, p. 41; vol. XII, p. 18; Coll., Forh. Vid. Selsk. Christ., 1874, p. 163; ibid., Tillægsh., p. 56; Hansson, Öfvers. Vet.-Akad. Förh., 1880, No. 4, p. 20; Day, *Fish. G:t Brit.*, *Irel.*, vol. I, p. 167, tab. LIII, fig. 1; Lillj., *Sv., Norg. Fisk.*, vol. I, p. 595; Hansen, *Zool. Dan.*, *Fiske*, p. 35, tab. VI, fig. 3 et 4.

The last two species, *Gobius microps* and *Gobius pictus*, in their typical form at least, never attain the maximum size of the Doubly-Spotted Goby. Their length seems never to exceed 50 mm. Furthermore, in relation to the latter species, they respectively range themselves in such a position that they represent its juvenile stages, *Gobius microps* in the anterior boundary of the scales, *Gobius pictus* in the relatively large size of the eyes, and both in the smaller number of rays which they generally possess in the dorsal and anal fins. Their Swedish names, *Lerstubb* ("Clay Goby") and *Bergstubb* ("Rock Goby"), which were happily chosen by Malm, and are derived from the nature of the spots they most frequent, give us the clue to the explanation of their chromatic characters, if we bear in mind the variations of colour given above, which Heincke observed in *Gobius flavescens* as being evidently due to changes in the colour of the surroundings of the fish. But they are distinguished from *Gobius flavescens* and approximated to *Gobius minutus* by a black spot, with azure lustre, between the 5th and 6th rays of the first dorsal fin, and sometimes behind the latter ray as well[b]. This spot occurs in the males and sometimes in the females, though there it is never so prominent or so lustrous. Another transition to *Gobius minutus* appears in the form of the body, the least depth of the tail sometimes sinking as low as 6 % of the length of the body; and specimens in which this is the case, can be distinguished from *Gobius minutus* only by the number of the scales along and across the sides of the body, a distinction which is often delusive, and by the usually smaller number of rays in the second dorsal and anal fins. Again, Heincke regards both *Gobius microps* and *Gobius pictus* as forming a variety of *Gobius minutus*.

In Bohuslän both these species are common at suitable spots. In Denmark, where, we need hardly say, the bottom of the sea consists chiefly of loose soil, sand, gravel and clay, *Gobius microps*, according to Winther, is the commonest species of the genus. "It lives in shallow water, from shore out to a depth of 5 or 6 fathoms, and is by no means averse to brackish water." In Norway, where the bottom of the sea for the most part is rocky, "*Gobius microps*," says Collett, "is of only sporadic occurrence and is met with far more seldom than *Gobius pictus*." At suitable spots, however, where the shore is shelving and clayey, in

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[a] Sometimes 20, according to Day.

[b] The supposed difference in the position of the spots on the dorsal fin, that in *Gobius microps* they belong to the rays and in *Gobius pictus* to the fin-membrane, has not proved constant. The first dorsal fin, too, seems generally to be shorter in *Gobius pictus*, and the distance between the first ray of the first dorsal fin and that of the second less (less than 14 % of the length of the body): but there are also exceptions to this rule.

Christiania Fjord for example, Collett met with the former species "in enormous numbers." In Denmark, up to the year 1885, according to Winther and Hansen, only 4 specimens of *Gobius pictus* had been found. According to Day, on the other hand, it had been met with on the Welsh coast; and, as it is probably synonymous with Moreau's *Gobius laticeps*[a], it also occurs on the coast of Normandy.

These two "species" also occur in the Baltic, though, as far as we can ascertain, not in their fully typical form. At Gudhjem (Bornholm) Dr. Kolmodin has taken a Goby 36 mm. in length, with the head 8 mm. long, the longitudinal diameter of the eyes, which were almost contiguous on the forehead, measuring $2^1/_2$ mm., and the least depth of the tail slightly more than 2 mm., the fish thus possessing the eyes of *Gobius pictus*, but the form of *Gobius minutus*. Mr. C. A. Hansson too, has taken at Rödö, in the neighbourhood of Sundsvall, a specimen of *Gobius microps*, typical in the form of the body, but by the number of the scales referred to *Gobius minutus*. Specimens similar to these and others which have been described as "doubtful examples," indicate the influence of external circumstances on form as well as on colour, and render the distinctions between the small Gobies difficult, if not impossible, to maintain.

Winther and Malm have both given the fullest descriptions, based on their own observations, of the habits of *Gobius microps*, and the latter of those of *Gobius pictus*. Both these fishes generally live in water of no great depth, and on sunny days often stay close in shore. Malm writes as follows of *Gobius microps:* "It keeps to the bottom, upon which it rests; and it is then so like a shrimp (*Crangon*) both in colour and habitus, that one may easily be deceived. It takes a bait so freely that I have often caught fifty examples in an hour at the same spot." Of *Gobius pictus* the same writer says: "The females, which kept to the very bottom and close in shore, among stones and seaweed, often at a depth of no more than an inch or two, and in company with a few females of *Gobius microps*, were easily taken on the hook; but the males, on the other hand, were extremely cautious and hardly ever took a bait. When frightened, they took refuge under stones and seaweed, but soon reappeared when the hook was cast afresh .... At the beginning of July I took several females full of roe, but in the middle of the same month several spent ones, a decisive proof that the spawning-season occurs at about midsummer. The males were at least from 6 to 8 times as rare as the females." At certain spots, however, Collett sometimes (in autumn) found, almost without exception, only males of *Gobius pictus*. According to Winther *Gobius microps* is most active at night, and is then often caught in shrimp-pots. In winter, according to Collett, these fishes withdraw into deep water; but as early as the beginning of March, the day after the breaking up of the ice in the Sound, Winther found numerous examples of *Gobius microps* at a depth of a foot or two.

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[a] *Hist. Nat. Poiss. Fr.*, tome II, p. 215.

GOBIUS ORCA.

Fig. 66.

Base of the second dorsal fin about equal in length to the peduncle of the tail, the least depth of which is more than 7 % of the length of the body. Eyes superiorly almost or quite contiguous, their longitudinal diameter being about 46 % of the length of the head. Number of scales in a row along the sides of the body about 24. Forehead and throat scaleless. Six or seven rays in the first dorsal fin. Funnel formed by the ventral fins incomplete, the membrane uniting the fins being wanting in front. Body of a uniform grayish brown without distinct spots or bands, only with a darker shading on the sides below the beginning of the first dorsal fin, at the end of the anal fin and at the base of the caudal fin. First dorsal fin high and, like the anal fin, of a uniform brownish black; second dorsal fin (in the male?) marked with alternate, brownish black and snow-white bands.

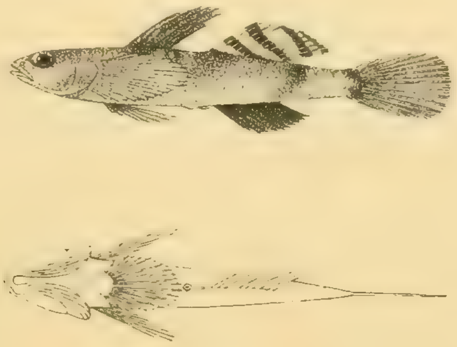

Fig. 66. *Gobius orca* Magn. 2 diam. Specimen belonging to the Zoological Museum of Christiania University.

D. 6—7 $\frac{1}{9\text{—}10}$; *A.* $\frac{1}{8}$; *P.* 17; *V.* $^{1}{}_{5}$; *C.* $x+13+x$; *L. lat.* circ. 24.

Syn. *Gobius orca*, Coll., Ann. Mag. Nat. Hist., ser. 4, vol. XIII, p. 446; Forh. Vid. Selsk. Christ. 1874, p. 172, tab. III, figg. 1—3; ibid., Tillægsh. p. 57; ibid. 1879, No. 1, p. 34 (*Lebetus*); N. Mag. Naturv., Christ., Bd. 29, p. 61, tab. I, fig. 1—2; Lillj. (*Gobius*), *Sv., Norg. Fisk.*, vol. 1, p. 616.

GOBIUS SCORPIOIDES.

Fig. 67.

Base of the second dorsal fin about equal in length to the peduncle of the tail or longer: the least depth of the latter more than 7 % of the length of the body. Eyes superiorly only slightly[a] *separated from each other, their longitudinal diameter being about 36 %*[b] *of the length of the head. Number of scales in a row along the sides of the body about 28*[c]. *Forehead and throat scaleless. Six rays in the first dorsal fin. Funnel formed by the ventral fins anteriorly incomplete. Ground-colour of the body whitish-yellow*[d], *with large, irregular, brownish black, transverse bands.*

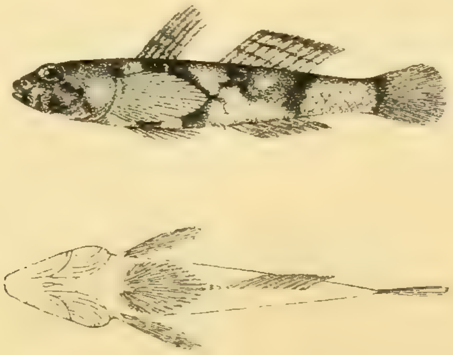

Fig. 67. *Gobius scorpioides*, magn. $1^2/_3$ diam. Specimen belonging to the Zoological Museum of Christiania University.

$D.\ 6\frac{1}{8};\ A.\ \frac{1}{7};\ P.\ 18\text{–}20;\ V.\ ^1/_5;\ C.\ x+12+x;$ *L. lat.* circ. 28—30.

Syn. *Gobius scorpioides*, COLL., Ann., Mag. Nat. Hist., ser. 4, vol. XIII, p. 446; Forh. Vid. Selsk. Christ. 1874, p. 175, tab. III, figs. 4—6; ibid., Tillægsh., p. 58; WINTH. (*Lebetus*), Naturh. Tidskr. Kbhvn, ser. 3, vol. XI, p. 49; vol. XII, p. 18; MALM, *Gbgs. Boh. Fn.*, p. 651; LILLJ. (*Gobius*), *Sv., Norg. Fisk.*, vol. I. p. 620; HANSEN, *Zool. Dan., Fiske*, p. 36, tab. VI, fig. 7.

Gobius orca and *Gobius scorpioides* have hitherto been examined almost exclusively by COLLETT. Of the former species he has mentioned 5 more or less well-preserved specimens, from 24 to 32 mm. long, which were taken off the south-west coast of Norway, at a depth of from 30 to 200 fathoms. Only three specimens of the latter species are known. Two, respectively 28 and 37 mm. in length, were taken by G. O. SARS at a depth of from 20 to 60 fathoms, outside Stavanger Fjord and Hardanger Fjord. The third, a young specimen $18^1/_2$ mm. long, and probably referred to this species chiefly on account of its coloration, was found by WINTHER at a depth of 6 fathoms, in the south-west of the Cattegat (at the north entrance of the Great Belt). Of their manner of life nothing further is known.

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[a] Distinctly, according to WINTHER.
[b] 27 % ,, ,, ,,
[c] About 30 ,, ,, ,,
[d] Deep rose-colour ,, ,, ,,

JEFFREYS' GOBY.

GOBIUS JEFFREYSII.

Fig. 68.

Base of the second dorsal fin about equal in length to the peduncle of the tail, the least depth of which is about 7 % of the length of the body. Eyes superiorly only slightly separated from each other, their longitudinal diameter being about 30 % of the length of the head. Number of scales in a row along the sides of the body about 28, and in a transverse row at the beginning of the anal fin about 6. Forehead and occiput naked, throat in front of the ventral fins scaly. Six or five rays in the first dorsal fin, the second ray being elongated in the male. Funnel formed by the ventral fins complete. Caudal fin somewhat pointed. Ground-colour of the body greenish yellow, with five black spots in a row along the middle of the sides.

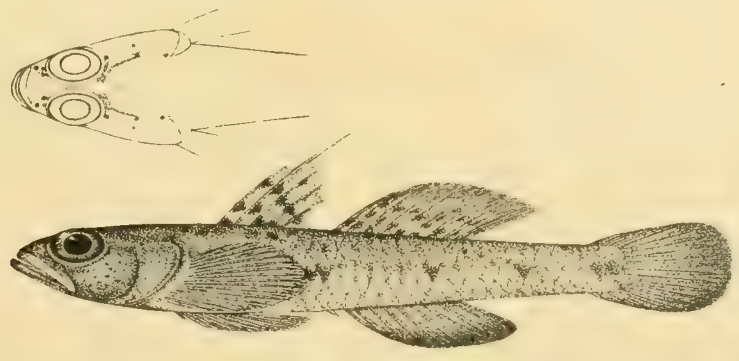

Fig. 68. *Gobius Jeffreysii*, Haugesund (Norway), W. LILLJEBORG, magn. 2 diam. Specimen belonging to Upsala Museum.

$D.\ (5)\ 6\,\frac{1}{9};\ A.\ \frac{1}{8};\ P.\ 16\ \text{l.}\ 17;\ V.\ {}^{1}/_{5};\ C.\ x+11(+1)+x;$ *L. lat.* circ. 28.

Syn. *Gobius Jeffreysii*, GTHR, Ann. Mag. Nat. Hist., ser. 3, vol. 20, p. 290, tab. V, fig. *C*; ser. 4, vol. 13 (1874), p. 139; COLL., Forh. Vid. Selsk. Christ. 1874, p. 159; ibid., Tillægsh., p. 54; LILLJ., *Sv., Norg. Fisk.*, vol. I, p. 587.
Gobius quadrimaculatus, DAY, *Fish. Gt. Brit., Irel.*, vol. I, p. 168, tab. LIII, fig. 2 (nec RISSO, CANESTRINI, cett.?).

Jeffreys' Goby, with its body of fairly uniform depth, but still elongated and laterally compressed in the caudal part, is ranged by the scales on the throat (the front part of the belly) as an intermediate form between the preceding species and the following one. Its other chief distinctions are the large scales, the depression of the head in typical specimens and the somewhat sharply upturned eyes. Both nostrils on each side of the snout are surrounded by a raised margin and set in a swelling common to them both, just in front of the middle of the anterior margin of the eye. Just behind them and nearer the middle of the snout lies a large pore belonging to the supraorbital branch of the system of the lateral line, which is furnished with other similar pores behind the eyes and in the temporal line on the parietal bones. The length of the lower jaw (about $10^{1}/_{2}$ % of the length of the body and 45 % of that of the head) is apparently greater than in our other small Gobies, and is distinctly more than $^{1}/_{3}$ of the distance between the beginning of the first dorsal fin and the tip of the snout. In this last respect Jeffreys' Goby corresponds to *Gobius niger* and *Gob. Friesii*, but even here we find intermediate forms, such as those taken by THEEL and TRYBOM at a depth of from 10 to 17 fathoms, on Lilla Middelgrund (a sandbank in the Cattegat), among them being a specimen with 7 rays in the first dorsal fin[a]. These forms may be referred with about equal justice to *Gobius flavescens*, *Gob. Jeffreysii* or *Gob. minutus*, unless we choose to follow the method hitherto adopted, and found new species on such examples[b].

[a] In the specimen of *Gobius Jeffreysii* taken by LILLJEBORG at Haugesund, there are only 5 rays in the first dorsal fin, this being due to the stunted development of the last ray.

[b] DAY has established one such species under the name of *Gobius Parnelli* (*Fish. Gt. Brit., Irel.*, vol. I, p. 167, plate LII, fig. 5).

Jeffreys' Goby is a rare species. Three specimens have been taken by Gwyn Jeffreys off the Hebrides at a depth of from 60 to 90 fathoms, one by Wyville Thompson at a depth of 180 fathoms between Shetland and the Faroe Islands, four by G. O. Sars in deep water outside Stavanger Fjord, and one by Lilljeborg at Haugesund. This last specimen has been lent us for examination by the Museum of Upsala University.

THE FRECKLED GOBY (SW. SANDSTUBBEN[a] OR SABBIKEN[b]).

GOBIUS MINUTUS.

Plate XIII, fig. 7.

Second dorsal fin relatively short, the length of its base being about $^3/_5$ of the distance between the first dorsal fin and the snout. Peduncle of the tail long and low, its least depth being less than $^2/_5$ either of its own length or of the distance between the first ray of the first dorsal fin and that of the second, and its length from the end of the base of the second dorsal fin to the first upper supporting ray of the caudal fin equal to, or only slightly less than (at least about 80 % of) the base of the second dorsal fin. Longitudinal diameter of the eyes in full-grown specimens less, or at most only slightly more, than $^1/_4$ of the length of the head. Caudal fin truncate or rounded. The two dorsal fins distinctly separated, with at least 2 (sometimes as many as 7) rows of scales between them. Scales comparatively small, about 60 in a row along the sides of the body, and from 12 to 14 in a transverse row on the body at the beginning of the anal fin. Scales anteriorly extending, in full-grown specimens, on the dorsal side to the top of the head, in front of the gill-openings, and on the abdominal side over the whole of the throat (the front part of the belly). Coloration yellowish, with dark (black or dark brown) spots, which are most distinct, and sometimes form transverse bands, at the middle of the sides and the base of the caudal fin, which is also marked with transverse bands. Among the rows of spots on the dorsal fins the lustrous, azure spot at the end of the first dorsal fin in the male is especially conspicuous.

R. br. 5: *D.* (5) 6(7) $\frac{1}{10 \text{ l. } 11}$[c]; *A.* $\frac{1}{10 \text{ l. } 11}$[d]; *P.* 18—21; *V.* $^1/_5$: *C.* $x + 11 (+1) + x$; *L. lat.* circ. 60.

Syn. *Aphya cobites*, Rondel., Willughby (p. 207, tab. X, 14, fig. 4): *Gobius aphya*, Art. p. p. (*Gen.*, p. 29; *Syn.*, p. 47); Lin. p. p. *Syst. Nat.*, ed. X, tom. I, p. 263; Gron., *Zoophyl.*, fasc. I, p. 81; Penn. (*Spotted Goby*), *Brit. Zool.*, tom. III, p. 187, tab. XXXVII, No. 96.

Gobius minutus, Pall. (Gronov. emend.), *Spic. Zool.*, fasc. VIII, p. 4; Gmel., *Syst. Nat. Lin.*, ed. XIII, tom. I, p. 1199; Nilss. (p. p.), *Prodr. Ichth. Scand.*, p. 94; Ekstr., Vet.-Akad. Handl. 1834, p. 64; Cuv., Val., *Hist. Nat. Poiss.*, vol. XII, p. 39; Fr., Vet.-Akad. Handl. 1838, p. 242; Kr., *Danm. Fiske*, vol. I, p. 407; Sundev., Stockh. Läns Hush. Sällsk. Handl., H. 6 (1855), p. 80; Nilss., *Skand. Fn.*, *Fisk.*, p. 222; Gthr, *Cat. Brit. Mus.*, *Fish.*, vol. III, p. 58; Mgrn, *Finl. Fisk.* (disp.), p. 17; Lindstr., *Gotl. Fisk.*, Gotl. L. Hush. Sällsk. Arsber. 1866, p. 15 (sep.); Steind., Stzber. Akad. Wiss. Wien, Bd. LVII, Abth. I (1868), p. 400; Wthr, Naturh. Tidskr. Kbhvn, ser. 3, vol. IX, p. 198; vol. XI, p. 54; vol. XII, p. 17; Coll., Forh. Vid. Selsk. Christ., 1874. p. 158; ibid., Tillægsh., p. 53; N. Mag. Naturv. Christ., Bd. 29 (1884), p. 60; Seidl., *Fauna Balt.*, Arch. Naturh. Liv-, Est-, und Kurl., ser. 2, vol. VIII, p. 121; Malm, *Gbgs, Boh. Fn.*, p. 433, tab. V, fig. 4; Hcke, Arch. f. Naturg., Jahrg. 46, Bd. I (1880), p. 313; Day, *Fish. G:t Brit., Irel.*, vol. I, p. 165, tab. LII, fig. 4; Mela, *Vert. Fenn.*, p. 284, tab. IX; Möb., Hcke, *Fisch. Osts.*, p. 54; Hansen, *Zool. Dan.*, *Fiske*, p. 34, tab. V, fig. 8; Lillj., *Sv., Norg. Fisk.*, vol. I, p. 580.

Gobius minutus (= ♀) + *Gob. unipunctatus* + *Gob. gracilis* (= ♂), Parn., *Fish. Firth of Forth*, Mem. Wern. Soc., vol. VII (1838), pp. 242—245, tab. XXIX.

Gobius Ekströmii, Gthr, l. c., p. 57.

Next to the Black Goby the Freckled Goby is the largest of the Scandinavian species of this genus. In Bohuslän its ordinary length varies between 50 and 100 mm. In the Baltic it attains a length of at least 75 mm. As Fries has already remarked, the typical form of this fish is expressed in the comparatively great length of the peduncle of the tail and the distance between the two dorsal fins, which varies in length, but is always distinct. It is further marked by the terete form of the body with the shallow tail, the least depth of which varies between 5 and 6 % of the length of the body, or seldom and only slightly exceeds this size, and also measures about $^1/_3$ of either the distance between the first ray of the first dorsal fin and that of the second, the base of the latter fin, or the length of the peduncle of the tail, which three measurements, in this species too, are almost alike[a]. The length of the head varies between 21 and 24 % of that of the body, being greater in the young specimens and in those from the Baltic, and the distance between the first dorsal fin and the tip of the snout varies between 28 and 31 % of the length of the body. The longitudinal diameter of the eyes, which are fairly closely approximating, but well separated, at the upper surface, is in young specimens about $^1/_4$ of the length of the head, in old about $^1/_5$, and only during youth greater than the least depth of the tail, in older specimens less than it. The length of the caudal fin is from 15 to 18 % of that of the body. The distance between the anal fin and the tip of the snout varies between 47 and 50 % of the length of the body (we have found this distance greater in the female than in the male); and the base of the anal fin is generally slightly shorter than that of the second dorsal, measuring between 15 and 17 % of the length of the body. The scales, which are comparatively small, in adult specimens usually number 13 or 14 in an oblique transverse row in a posterior direction from the beginning of the anal fin, and about 60 in a longitudinal row along the middle of the sides. In young specimens, however, even in those 40 mm. long, there are sometimes only 45 scales in the latter row, in which case the difference between *Gobius minutus* and *Gob. microps* is confined to the deeper tail of the latter. Heincke also regarded these Gobies as varieties of one and the same species.

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[a] Malm, l. c.

[b] Sundevall, l. c.

[c] Sometimes, though seldom, $\frac{1}{8}$ or $\frac{1}{12}$, according to Steindachner. Ekström's $\frac{1}{13}$ is probably due to a mistake(?).

[d] Sometimes, though seldom, $\frac{1}{9}$, according to Steindachner.

The coloration of the Freckled Goby, with all its variations, is principally the same as that of *Gobius microps*, and reproduces, though in fainter tints, the handsome markings possessed, according to Steindachner[b], by *Gob. quadrivittatus*. The ground-colour is whitish or grayish yellow, somewhat darker on the back, and dotted with dark brown chromatophores, which are most closely set in the hind margin of the dorsal scales. Light, selliform spots appear on the dorsal side in this species too, as well as a row of dark spots along the middle of the sides, or small, transverse bands, among which the caudal spot, at the base of the caudal fin, should also be included. There sometimes appear too, in this species as in the preceding ones, two dark bands at each eye, one running from the lower part of the anterior orbital margin in an oblique, forward direction along the snout, and the other perpendicularly downwards from the middle of the inferior orbital margin. "The belly is white, with a brassy lustre" (Ekström), this being due to the circumstance that the mother-of-pearl lustre of the peritoneum shines through. The dorsal and caudal fins are marked in the same way as in the preceding species. "The pectoral fins are grayish yellow, with dark rays, and strewn with fine, ferruginous dots" (Ekstr.). The ventral and anal fins in the female are generally white, in the males more or less thickly punctated with black. Sometimes, however, all these colours and markings are faded. "The whole fish is transparent," says Ekström, "and therefore, when it is put in water while still alive, and examined from above, the intestinal tract appears as a large, oval, black spot."

The geographical range of this fish extends from the Mediterranean, at least as far in as the Adriatic Sea, along the west coast of Europe to the north of Norway, where it has been found by Krøyer off Dyrö, in Lat. 69° N., and into the Baltic as far as the Gulf of Finland (Mela), the island-belt of Stockholm (Sundevall), and probably the Gulf of Bothnia as well. It lives in water of a depth as great as 12 or even 20 fathoms (Collett), deepest in winter; but in summer comes up near shore into water only a few feet deep (Malm). It prefers a level, sandy bottom, overgrown with seaweed (Ekstr.). The spawning-season occurs in summer from the end of May (Ekstr.) to August (Malm). Its food is generally composed of small crustaceans; and the following statement of Winther with regard to *Gobius microps*, also applies to the Freckled Goby. "The mouth is surrounded by fairly well-developed lips; and on the palate, within the intermaxillary bones, we find a narrow, crescent-shaped, transverse, membranous fold (velum). A similar fold lies immediately below it in the lower jaw. The function of these folds is easily understood; they operate in the same way as the valves of the veins in the circulation of the blood; when the mouth is being closed, they hinder the passage of the water, which is thus forced back through the gill-openings. They are, therefore, most highly developed in fishes whose teeth are too long to admit of the entire closing of the mouth, and to a certain extent they take the place of mobile lips, which might perform the same function. In spite of the somewhat small size of these folds in the Gobies, they are still sufficiently developed to enable the fish to maintain a continuous flow of water into the mouth, without moving the jaws. They only act when the mouth is open and while it is being closed. As soon as the mouth is shut, the lips serve the same purpose. But just because the folds operate only when the mouth is open, the fish is able to pump in water with its free, very broad and flat tongue, in exactly the same way as certain parts of the maxillary feet of the Decapods pump out water from the gill-sac. When the tongue is protruded, the water fills the pouches formed by the folds, the opening of the mouth is stopped, and the water is forced back. In this way many kinds of small creatures are caught which the fish would lose, if they were disturbed by the stronger motions of the jaws."

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[a] This is true, in particular, of the specimens from Bohuslän which we have been able to examine. In young specimens and those from the Baltic, the peduncle of the tail seems generally to be somewhat shorter, but also shallower.

[b] L. c., p. 399, plate II, figs. 3 and 4.

D'Orbigny[a] often observed the Freckled Goby in the salt-water reservoirs in the neighbourhood of La Rochelle, and he states that it there takes up its abode under some shell, and digs small hollows, radiating from this centre, in the sand. There it lies and watches, until some tiny creature falls into one of the hollows, when it instantly darts out and seizes its victim.

That the Freckled Goby, however, does not always feed on such small creatures, is shown by Sundevall's collections made in the island-belt of Stockholm. Among them we find a Freckled Goby, 50 mm. long, that has swallowed the third part of a Ten-spined Stickleback (*Gasterosteus pungitius*), of at least half its own length, which has, however, stuck in its throat, piercing its palate with the anterior dorsal spines.

According to Malm the Freckled Goby is also easy to catch, as it readily takes a hook baited with a bit of shellfish.

This species is of as little immediate value to man as the rest of the genus; but Heincke states that it forms the chief part of the food of the Cod and the Bullhead, and some portion of that of the Herring.

Genus **APHYA**.

Body fairly elongated, sides covered with thin, deciduous, cycloid scales. Simple, fixed, pointed or in part blunt teeth, in a single or double row, in the lower jaw and on the intermaxillary bones. Five rays in the first dorsal fin. Funnel formed by the ventral fins united to the ventral side only at the base. Gape comparatively large, and the jaws long, the least depth of the tail being at most 60 % of the length of the lower jaw, which is equal to, or more than, half the length of the head. Branchiostegal membranes coalescent only in front, at the tip of the isthmus, and the gill-openings, therefore, large and broad, set almost horizontally. Branchiostegal rays 5.

In England Whitebait (*Clupea alba*) is the name given to a number of small fishes, consisting chiefly of young Herrings, Sticklebacks etc., which are caught in considerable quantities, and, when fried, form a much esteemed dish; and in the countries bordering on the Mediterranean, *Nonnat*[b] or *Nounat* is the French name applied to fishes used in the same way, fried or stewed in milk, and consisting chiefly of young Atherines and the fry of the species which forms the genus *Aphya*. Even the ancient Greeks, however, had acquired a taste for this course of fish, quickly parboiled in oil, and called the small fishes *ἀφύη*[c], in the belief that they were not generated in the ordinary way, but "created in the water," to use an expression still in vogue among the Scandinavian fishermen (i. e., born of the sea-foam etc.). Aristotle, however, distinguished between several kinds of these fishes, and regarded some of them as really being the fry of other fishes. Among these he mentions *ἀφύη κωβίτης* as the young of small Gobies which creep on the bottom"[a]; and from this source RONDELET[b] derived his *Aphya cobites*, a species difficult to fix, but referred by ARTEDI and his immediate successors to *Gobius minutus* (see above). The first post-Linnaean writer to apply the name of *nonnat* to a fixed species, was RISSO. He originally referred this species to the genus *Atherina*, but when he corrected his mistake, he placed it in a new genus, *Aphia*, beside *Gobius*, but in the family next after it.

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[a] Valenciennes (Cuv., Val., l. c., p. 43).

[b] *Non natus.*

[c] *α* priv. and *φύω*, to beget.

To the systematist this genus is of special interest on account of its remarkable changes of growth and external sexual characters, which still further increase our hesitation to go to too great lengths in the distinction of species within the preceding genus, to which *Aphya* is by no means distantly related. In the only species belonging to this genus, the form of the body during youth (fig. 71, *b*) is elongated and compressed[c], reminding us especially of the fry of the Herring; and it is not until the sexual organs approach maturity, that the Gobioid appearance of this species is developed. The breadth of the body, especially of the head, now increases; and the interorbital space, which has hitherto been narrow, measuring only slightly more or even less than half the diameter of the eye, attains a breadth equal to the longitudinal diameter of the eye or, in the males, still greater (fig. 69). The most important, secondary, sexual distinction lies, however, in the form and size of the jaw-teeth. In the females they retain their juvenile arrangement, and are small, pointed, somewhat curved, of uniform size, and set fairly close together in a single row. In the full-grown males, on the other hand (fig. 70), these teeth disappear, in the front of the mouth at least, but are replaced by a fresh row of larger, more scattered and somewhat blunt teeth, 4 or 5 on each of the intermaxillary bones and 3 or 4 on each half of the lower jaw; and within this row, in the lower jaw at its end, but in the upper jaw farther forward towards the snout, there appears a recurved, canine tooth on each side. Though CANESTRINI[d] was the first to remark this difference in the teeth, it has been most fully elucidated by COLLETT[e], who also came to the conclusion that these fishes, as well as the following genus, are annual vertebrates, the only instances of the kind, which propagate their species when a year old, and die soon afterwards.

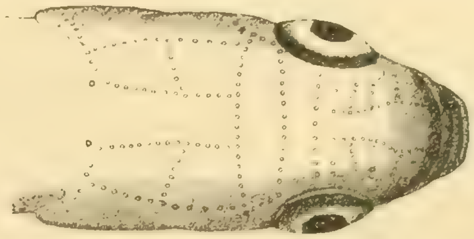

Fig. 69. *Aphya minuta*: head of an adult male, showing the longitudinal and transverse rows of papillæ belonging to the system of the lateral line, seen from above. Magnified. After COLLETT.

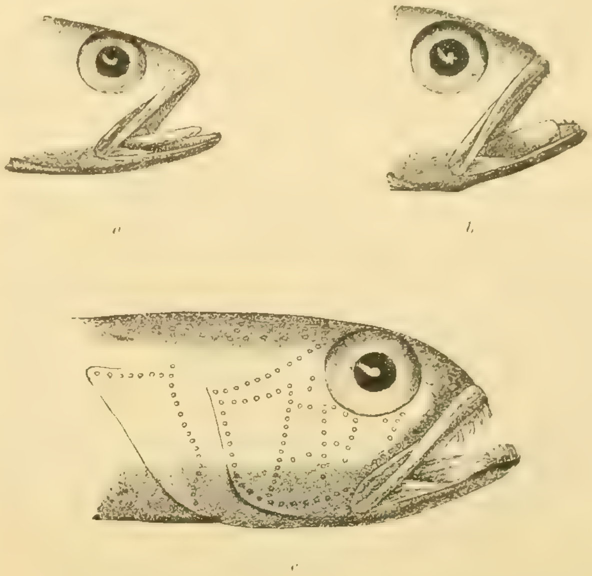

Fig. 70. *Aphya minuta*: head of a young male (*a*), during winter, of an older male (*b*), just before the spawning-season, and of a full-grown male (*c*), during the spawning-season: seen from the side. In the last figure is shown the extension of the lateral line on the side of the head. Magnified. After COLLETT.

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[a] *Anim. Hist.*, lib. VI, cap. 15.

[b] *De Piscibus*, lib. VII, cap. III.

[c] APICIUS took this form as his model, and though far from the sea, where it was quite impossible to obtain these fishes, thus procured for NICOMEDES, king of Bithynia, the coveted dainty, by cutting turnips into thin slices and thoroughly boiling them with spices in oil. (RONDEL., l. c., cap. II.)

[d] Arch. Zool., Anat., Fisiol. vol. I (Genova, Dec. 1861), p. 152. KESSLER (Bull. Soc. Imp. Nat. Moscou, tome XXXII (1859), No. 2, p. 260) had also remarked this difference, but only in individual cases, and without regarding it as a sexual distinction.

[e] Proc. Zool. Soc. Lond. 1878, p. 325.

THE WHITE GOBY (SW. KLARSTUBBEN[a]).

APHYA MINUTA.

Plate XIII, figs. 8 and 9.

Body so transparent, with a faint tinge of reddish or greenish yellow, that the internal organs are visible[b], *and dotted with black chromatophores, in youth chiefly at the bases of the second dorsal fin (sometimes not even there), the caudal fin and (most distinctly) the anal fin. In adult specimens there is also a distinct row of about 25 dark dots or collections of dots at the middle of the sides, one of these dots or collections of dots being placed in the space between each pair of the transverse sections of the lateral muscles, on the hind part of the body sometimes denser and forming a continuous streak along the middle of the sides. The whole dorsal side (sometimes the ventral sides proper as well) and the head, especially the tip of the snout and the point of the lower jaw, also strewn, in specimens ready to spawn in particular, with similar dark chromatophores, which also appear on the rays of the vertical fins, and generally mark the divisions between the lateral muscles by transverse rows of dots in an upward and downward direction from the middle of the sides.*

R. br. 5; *D.* $5\ \frac{1}{11\ \mathrm{l.}\ 12}$; *A.* $\frac{1}{12\ \mathrm{l.}\ 13}$; *P.* 16—18; *V.* $\frac{1}{5}$;
C. $x+11+x$; *L. lat.* 25 l. 26; *L. tr.* 5; *Vert.* 27.

Syn. *Atherina minuta*, *Risso*, *Ichthyol. de Nice*, p. 340; CUV., VAL., *Hist. Nat. Poiss.*, vol. X, p. 437.

Gobius pellucidus, NARDO, Giorn. Fis., Chim. Stor. nat., Pavia, III (1824), *Osservaz.* etc. p. 7; Isis, XX (1827) p. 479; KESSL., Bull. Soc. Imp. Natur. Moscou, XXXII (1859) No. III, p. 260; GTHR (*Latrunculus*), *Cat. Brit. Mus.*, *Fish.*, vol. III, p. 556; COUCH (*Gobius*), *Fish. Brit. Isl.*, vol. II, p. 171, tab. CII, fig. 2; COLL. (*Latrunculus*), Forh. Vid. Selsk. Christ., 1876, No. 6, p. 2, tab. I, fig. 1—8; Proc. Zool. Soc. Lond. 1878, p. 319; MOR. (*Aphya*), *Hist. Nat. Poiss. Fr.*, vol. II, p. 238; DAY (*Aphia*), *Fish. G:t Brit.*, *Irel.*, vol. I, p. 169; LILLJ. (*Aphya*), *Sv.*, *Norg. Fisk.*, vol. I, p. 626; COLL. (*Aphia*), N. Mag. Naturv. Christ., Bd. 29 (1884), p. 62.

Aphia meridionalis, RISSO, *Eur. Mér.*, tom. III, p. 288.

Gobius albus, PARN., Trans. Roy. Soc. Edinb., vol. XIV, p. 137; Mem. Wern. Nat. Hist. Soc., vol. VII (1837), p. 248, tab. XXIX; YARR., *Hist. Brit. Fish.*, ed. 2, vol. I, p. 295; CANESTR., *Arch. Zool. Anat. Fisiol.*, vol. I, p. 152, tab. VIII, fig. 3; GTHR (*Latrunculus*), *Cat. Brit. Mus.*, *Fish.*, vol. III, p. 80 et 556; MALM (*Gobius*) Förh. Skand. Naturf. Möte, Stockh. 1863, p. 411; COLL. (*Latrunculus*), Forh. Vid. Selsk. Christ. 1872, p. 8 (sep.); BLKR, Arch. Néerl. Sc. Exact., Natur., tome IX, p. 312; MALM, *Gbgs*, *Boh. Fn.*, p. 435, tab. VI, fig. 2.

Gobius Stuvitzii, v. DÜB., KOR., Öfvers. Vet.-Akad. Förh. 1844, p. 111; Vet.-Akad. Handl. 1844, p. 59, tab. II, fig. 4; NILSS., *Skand. Fn.*, *Fisk.*, p. 229; GTHR (*Gobiosoma*), l. c., p. 86; GILL (*Boreogobius*), Proc. Acad. Nat. Sc. Philad. 1863, p. 269; MALM (*Gobius*), Förh. Skand. Naturf. Möte, Stockh. 1863, p. 411; COLL. (*Latrunculus*), Forh. Vid. Selsk. Christ. 1872, p. 9 (sep.); ibid. 1874, Tillægsh., p. 59; BLKR (*Boreogobius*), l. c., p. 310; MALM (*Latrunculus*), *Gbgs*, *Boh. Fn.*, p. 439, tab. VI, fig. 3.

The great external difference of sex in the White Goby has found its expression in the numerous names it has borne in the system. In modern times the males (Plate XIII, fig. 8 and fig. 71, *a*) have been generally known by the name of *Latrunculus albus*, and the females (Plate XIII, fig. 9 and fig. 71. *c*), together with the young specimens (fig. 71, *b*), by that of *Latr.* (*Boreogobius*) *Stuvitzii*. The former were distinguished by the greater size of the teeth and the greater length of the rays at the end of the second dorsal and anal fins. These fishes were also long supposed to be the fry of some larger, still unknown Goby[c], until MALM in July, 1861, found gravid females from 42 to 48 mm. long, in Gullmar Fjord off Christineberg. In Scandinavia the males attain a length of at least 52 mm.[d]

In this species too, the greatest depth of the body varies considerably according to age and sex, measuring in young specimens 11 or 12 % of the length of the body, in adult males about $13^{1}/_{2}$ % and in gravid females, according to LILLJEBORG, as much as 18 %. The least depth of the body in young specimens, as well as in gravid females, is between 6 and $6^{1}/_{2}$ % of the length of the body, being thus nearly the same as in old specimens of *Gobius minutus*, while in adult males it is about 7 % of the length of the body, or about the same as in *Gobius Jeffreysii*. The length of the head, which is even relatively less in young specimens than in old, especially in the males, varies between 18 and 21 % of that of the body, and its greatest thickness in the former is less than 50 % of its length, in the latter at least 90 % thereof. The length of the snout in the former is about equal to the longitudinal diameter of the eye, which varies between 26 % and 28 % of the length of the head; while in the males it is greater than the diameter of the eye, which in their case is about 24 % of the length of the head. The adult females occupy an intermediate position in this respect, as in several others. In young specimens and adult females the length of the lower jaw measures 10 or 11 % of the length of the body, in adult males 13 %. In young specimens, according to v. DÜBEN and KOREN, the distance between the beginning of the first dorsal fin and the tip of the snout is 28 or $28^{1}/_{2}$ % of the length of the body. In older specimens, especially in the males, this distance is even relatively greater, measuring 30 or 31 % of the length of the body. In young specimens the base of this fin is less than $^{1}/_{3}$, in gravid females exactly $^{1}/_{3}$, and in adult males nearly $^{1}/_{2}$, of the distance between the first ray of the first dorsal fin and that of the second, this distance being, however, less in the males than in the females, measuring about 13 % of the length of the body in the former and about 15 % in the latter. The base of the second dorsal fin is also longest in the adult males, its length varying between 19 and 22 % of that of the body. The relative length of the anal fin, on the other hand, diminishes with increasing age and the development of the sexual characters, being 20 or 21 % of the length of the body in young specimens, 16 or 17 % in adult. We have already remarked the male character common in the Gobies, which in this species too, is expressed by the elongation of the posterior rays in the two fins last mentioned. The beginning of the anal fin lies just in front of the middle of the body, its distance from the tip of the snout in the females being about 49 % of the length of the body, in the males about 47 %. The length of the caudal fin increases even relatively with age, and is greatest in the adult males, varying between 13 and 22 % of the length of the body.

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[a] MALM, l. c.

[b] This is true only of the living fish. When preserved in spirits, it is an opaque, whitish yellow.

[c] This was PARNELL'S assumption as to the males, and v. DÜBEN and KOREN'S as to the females and the specimens where the external differences of sex were not yet developed. The former also cites an opinion then current among the Scotch fishermen, that these fishes were the young of *Trachinus vipera*.

[d] From 40 to 50 mm. in more southern latitudes, according to MOREAU; only slightly more than 38 mm., according to DAY.

The distribution of the scales on the body is shown in the figures we have taken from COLLETT's work, and the coloration, as far as its transparent nature could be reproduced, in the two figures which we have borrowed of MALM.

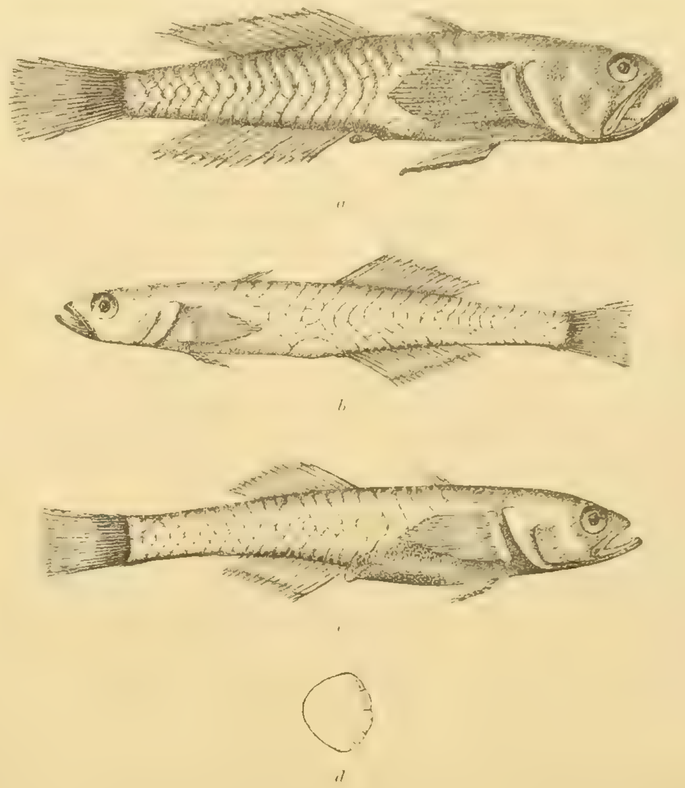

Fig. 71. *Aphya minuta*: *a*. adult male, in the spawning-season: *b*, young male in winter: *c*, gravid female. Magn. 2 diam. *d*. a scale from the middle of the side, more powerfully magnified. After COLLETT.

In Scandinavia the White Goby has not yet been utilised as an article of food. The large numbers in which it occurs, occasionally at least, in Christiania Fjord, where COLLETT[a] at the end of November, 1880, for example, took about 40,000 at a single haul of the seine, among the Herring-fry, give us good reason to expect that here in Scandinavia, on the Norwegian coast and perhaps in Gullmar Fjord, where the species also occurs, with suitable tackle we may be able to establish a fishery similar to that of more southern countries. There, according to RISSO and MOREAU, these *nonnats* are caught in a fine-meshed kind of purse-net (*Tartane* or *Tartaneum*), which is sunk to a depth of between 15 and 18 fathoms. In this manner, according to G. O. Sars, large quantities of this fish are taken both in the Adriatic and off the coast of Sicily.

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[a] N. Mag. Naturv., l. c., p. 63.

The White Goby spawns in summer. Collett found that the males change their teeth during May; and in June the females were full of roe. At the beginning of July, most of the males had emptied their milt-sacs; and after that date he did not see a single specimen until he met with the fry in the autumn.

The White Goby is common in the Mediterranean and the Black Sea. Off the south part of the west coast of Europe it has not yet been observed, but it has been found in Scotland and along the Norwegian coast up to the neighbourhood of Bergen. Its Scandinavian haunts were first discovered by the eminent Norwegian naturalist Stuvitz, who took four specimens off Bergen, in December, 1834. The species of these examples, however, was not determined until ten years afterwards, by v. Düben and Koren. In Sweden it was first found in Gullmar Fjord, in July, 1858, by G. M. Retzius. In 1859 it was taken off Skåreberg in Gullmar Fjord by S. Lovén, and in the same year by Lilljeborg. Since that time it has again been found in the same neighbourhood by A. W. Malm, and at Strömstad it has been taken in Salmon-traps by C. A. Hansson, in June, 1880, and May, 1887.

The food of the White Goby is composed of small crustaceans and their young and larvæ, as well as those of shellfish. It serves in its turn as food for other fishes, and in this capacity is of special importance to the small *Gadidæ* and the young of the larger ones. Collett found the stomach of these fishes in several instances crammed with White Gobies.

Genus **CRYSTALLOGOBIUS**[a].

Body elongated, laterally compressed and scaleless. Teeth simple, fixed, and set in a single row, present only in the front part of the lower jaw and the intermaxillary bones; in the female extremely small, in the male more prominent and interspersed with canines in the lower jaw. Two rays in the first dorsal fin. Funnel formed by the ventral fins with the outer (anterior) rays branched, open posteriorly, and with each of the two innermost rays united by a membrane to the belly. Gape relatively large, the length of the lower jaw being more than $^1/_2$ that of the head. Gill-openings large, obliquely horizontal, extending forward to the point of the isthmus. Branchiostegal rays 5.

This northern genus may be regarded as almost peculiar to the Scandinavian fauna. In the system it forms a link between the preceding genera and the *Amblyopiformes*, which are distinguished by the continuous vertical fins and the more lobate pectoral fins, and, like the males of *Crystallogobius*, are often furnished with well-developed, canine teeth.

The only known species of the genus is

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[a] Gill, Proc. Acad. Nat. Sc. Philad. 1863, p. 269.

CRYSTALLOGOBIUS NILSSONII.

Fig. 72.

Body during life highly transparent, with a row of dark chromatophores, in most cases one for each ray, on each side of the bases of the second dorsal, caudal and anal fins, and at the lower margin of the belly proper. Three or four small spots (consisting of several pigment-cells) on each side of the belly, and (in the males) a row of chromatophores on the under surface of each of the two branches of the lower jaw, the articulation of which is marked in both sexes by a black spot. Vertebræ 29.

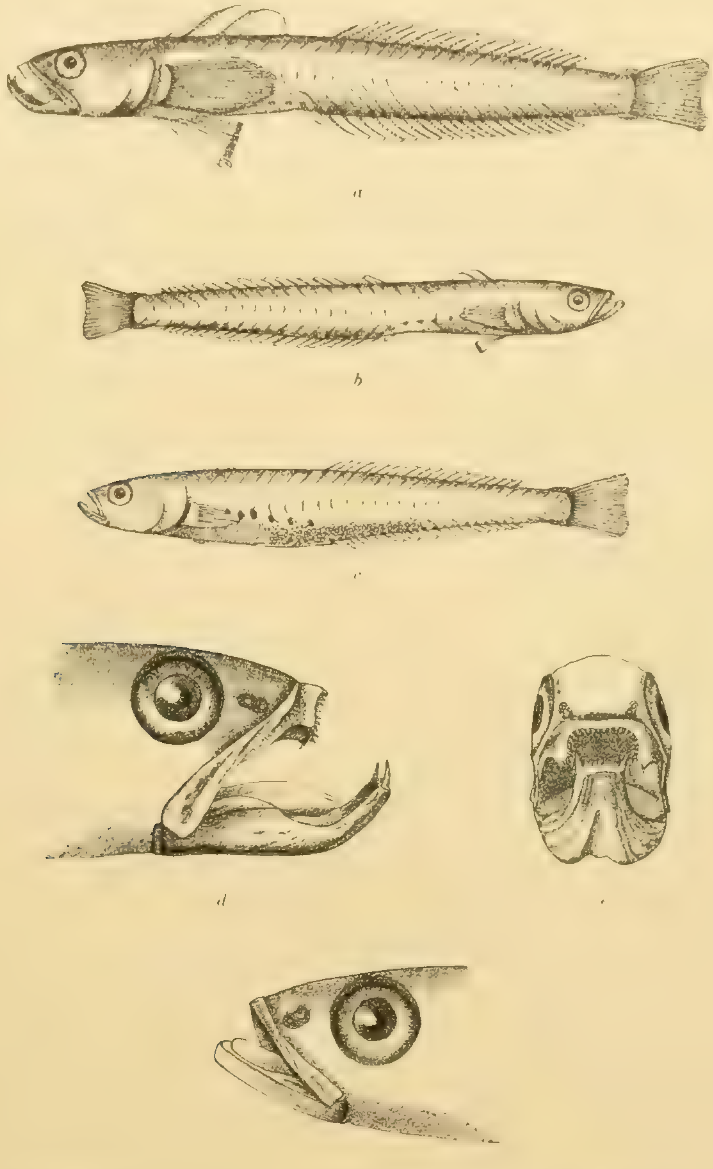

Fig. 72. *Crystallogobius Nilssonii.* After Collett. *a—c*, magn. 2 diam.; *d—f*, magn. 6 diam. *a:* adult male, in the spawning-season; *b:* young male; *c:* female, with ripe roe; *d:* head of an adult male, during the spawning-season; *e:* the same, seen from in front; *f:* head of a gravid female.

R. br. 5; *D.* 2|19—20[a]; *A.* 20—21[b]; *P.* 29—30; *V.* $\frac{0}{6}$; *C.* $x + 11 + x$.

Syn. *Gobius linearis*, v. Düb., Kor., Öfvers. Vet.-Akad. Förh. 1844, p. 111. *Gobius Nilssonii*, v. Düb., Kor., ibid. 1845, p. 11; Vet.-Akad. Hand. 1844, p. 53, tab. II, fig. 3; Nilss., *Skand. Fn., Fisk.*, p. 227; Gthr (*Gobiosoma*), *Cat. Brit. Mus., Fish.*, vol. III, p. 86; Coll. (*Latrunculus*), Forh. Vid. Selsk. Christ. 1872, p. 9 (sep.); Blkr (*Cristallogobius*), Arch. Néerl. Sc. Exact.,

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[a] Sometimes 21, according to v. Düben and Koren.

[b] „ 22, „ „ „ „ „

Nat., tom. IX (1874), p. 310; Coll. (*Latrunculodes*), Forh. Vid. Selsk. Christ. 1874, p. 151; ibid., Tillægsh., p. 60; Id. (*Crystallogobius*), ibid. 1876, No. 6, p. 26, tab. II, fig. 9—14; Malm, *Gbgs, Boh. Fn.*, p. 651; Coll., l. c. 1879, No. 1, p. 36; Day, *Fish. G:t Brit., Irel,*, vol. I, p. 172, tab. LIII, fig. 4; Lillj., *Sv., Norg. Fisk.*, vol. I, p. 640; Coll., N. Mag. Naturv., Christ,, Bd. 29 (1884), p. 63.

Crystallogobius Nilssonii, is essentially of the same form as the preceding species, and of equal or even greater transparency. The body is, however, still more strongly compressed; and the great length of the second dorsal and the anal fins, the shortness of the first dorsal fin, and the arcuate, upturned form of the lower jaw, with the peculiar structure of the teeth in the male (fig. 72, *d* and *e*), combine to give this species an entirely different appearance. Another remarkable point in this fish is the broad (multiradiate), somewhat lobate form of the pectoral fins, with their semicircular, muscular root and elongated, roundish shape, furnished as they are with short, fine rays at the top and bottom, and with the middle 12—14 rays longest, though much shorter than in the preceding species, and even in the males only about 10 % of the length of the body.[a] When expanded, the pectoral fins are as deep as the body. The development of the fins in this species is, however, widely different in the different sexes. The second ray in the first dorsal fin is the longer, and the fin-membrane sometimes extends back to the beginning of the second dorsal fin, but is generally much shorter. In the females (fig. 72, *c*) this fin is remarkably low, being often scarcely distinguishable, which is also the case with the ventral fins, while the second dorsal and anal fins are also lower in the female than in the male, and the pectoral fins much shorter. According to v. Düben and Koren's measurements of specimens from 31 to 42 mm. long, the fins also undergo considerable changes of growth, the base of the second dorsal fin increasing from 30 to 35 % of the length of the body, the base of the anal fin, on the other hand, being reduced from 36 to 35 % thereof, while the distance between the tip of the lower jaw and the vent is reduced from 45 to 42 % of the length of the body, and the distance between the first dorsal fin and the tip of the snout from 23 to 22 %. According to the same measurements the greatest depth of the body sinks from 13 to 11 % of the length, and the least depth from 8 to 7 %. Again, according to the same measurements, the length of the head is about 17 % of that of the body; but in two females, 33 and 38 mm. long, sent us from Christiania Fjord, by Professor Collett, this ratio varies between 15 and 16 %, and in two males from the same place, 44 and 45 mm. long, it is 20 %. The longitudinal diameter of the eye decreases, according to v. Düben and Koren, from 29 to $23^{1}/_{2}$ % of the length of the head. In our own specimens the length of the lower jaw varies between $56^{1}/_{2}$ and 60 % of that of the head.

To the best of our knowledge *Crystallogobius Nilssonii* has only twice been found in Sweden, on both occasions near the entrance of Gullmar Fjord. In July, 1877, off Gåsö, Malm found a male and a female which had probably been drawn up in a net from a depth of 14 fathoms; and among the collections which Dr. Wirén brought with him in 1885 from the Zoological Station of Christineberg, was a male specimen 36 mm. in length. On the Norwegian coast, on the other hand, it has repeatedly been met with, in some years in fairly large numbers, though at other times, like the preceding species, it seems to be extremely rare. The first specimens, 5 in number, were taken by Stuvitz off Steen, near Bergen, in December, 1834. Off Askewold, in the north of the Department of Bergen, Governor Christie took two specimens, which were also placed at v. Düben and Koren's disposal in the Museum of Bergen. These writers also mention two other specimens which they had personally taken in a dredge, at a depth of about 30 fathoms, off Christianssund, in July, 1843. Each of these specimens was found hidden in the empty shell of a worm (*Chætopterus norvegicus*). Both of the Norwegian zoologists Sars have subsequently met with this species at several spots in the south of Norway; and in recent years, from 1875 to the present time, it has repeatedly been found by Collett during the seine-fishery for Mackerel, Sprats and Cod in Christiania Fjord. In June, 1879, in particular, he took about a hundred specimens among a small shoal of Herrings that was netted in Sandvig, some Swedish miles south-west of Christiania. June is approximately the spawning-season of this species; and its habits are in all probability much like those of *Aphya minuta*, in company with which it is often found. Like the latter species it is also comprised among the fishes called *Aat* by the Norwegians, and may be of no small importance as food for other fishes, especially young Cod, small *Gadidæ* and Herrings. The want of regularity in its annual appearance at a certain spot may, therefore, be well deserving of careful investigation, as we may possibly find herein a clue to the explanation of the varying occurrence of these last species at different spots and in different years.

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[a] In this respect Collett's figure is less accurate than v. Düben and Koren's and Day's figures above referred to.

Crystallogobius Nilssonii has only once been found out of Scandinavia. This find was made in Scotland, where, according to Day, in May, 1868, Edward discovered a male specimen in a pool on the shore near Banff.

Fam. CALLIONYMIDÆ.

Body elongated, more or less Cottiform, anteriorly depressed and posteriorly terete or of a rounded quadrangular shape. Two dorsal fins, the base of the anterior shorter than that of the posterior, and the former composed of flexible, simple rays. Anal fin in structure and position analogous to the second dorsal. Ventral fins of normal structure and set far apart, but jugular, and generally longer and broader than the pectoral fins. Pseudobranchiæ present. Six branchiostegal rays. Air-bladder and pyloric appendages wanting. No osseous connexion between the suborbital ring and the preoperculum.

Bonaparte defined and established this family[a] as a subfamily (*Callionymini*) of the Gobioids, and Valenciennes made the suggestion[b] afterwards adopted by Richardson[c], when he gave the family the above name. It is probably a question of no great importance whether we follow Cuvier and Günther, and retain the Dragonets within the Gobioid family, or place them as a distinct family beside the latter. Like the Gobies they are bottom-fishes, with the form of the body still better adapted to their manner of life, depressed as it is, sometimes almost to the base of the caudal fin. In addition to the common character which lies in the structure of the first dorsal fin, with its flexible rays and short, but sometimes remarkably high shape the resemblance between the Dragonets and the Gobies is further enhanced, in particular, by the similarity of their external sexual characters. Distinctive characters for these families are, however, not wanting. In the Dragonets the mouth admits of protrusion; and the jugular ventral fins are set so far apart that the posterior part of their membrane projects upwards along the front of the base of the pectoral fins.

The family of the Dragonets is not rich in forms. About 30 species are known, all but one, *Callionymus Agassizii*, which, during the voyages of the American steamer "Blake" between 1877 and 1880, was found at a depth of 340 fathoms in the Gulf of Mexico[d], belonging to the Eastern Hemisphere. By far the greater part of them belong to the genus

CALLIONYMUS.

Body naked, scales appearing, in some cases only, on the lateral line. Small, cardiform teeth on the intermaxillary bones and in the lower jaw. The lower posterior corner of the preoperculum prolonged into a spinous point. Gill-openings small, sometimes shrunk into two, round foramina, one on each side of the occiput. Vertebræ about 20[e].

The ancient writers did not know this fish, to which Linnæus[f] has applied the generic name of *Callionymus*, derived from Aristotle[g], who used it, however, according to Athenæus and Pliny, as a synonym of *Uranoscopus*. One of the Scandinavian species was also originally[a] called *Uranoscopus* by LINNÆUS, though he afterwards changed the name to *Trachinus*[b]. The oldest generic name, *Dracunculus*, derived from PLINY, and intended to indicate the likeness to *Trachinus* (*Draco*), was applied by RONDELET[c] to a Mediterranean species of the genus, which was referred by ARTEDI to the genus *Cottus*[d]. The Swedish name "*Sjökock*" (Sea-cook), according to FRIES[e], really signifies Sea-cock; and "*Flygfisk*" (Flying-fish), another Swedish name for this genus, is an unconscious reminiscence of *Exocoetus*, the name applied to the genus by GESNER and BELON[f].

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[a] See *Isis*, 1833, p. 1199.

[b] Cuv., Val., *Hist. Nat. Poiss.*, vol. XII, p. 262.

[c] *Zool. Ereb.*, *Terr.*, II. 2 (*Ichthyol.*). Method. List, p. IV.

[d] Bull. Mus. Comp. Zool., Harv. Coll., Mass., vol. XV, p. 29, fig. 207.

[e] From 19 to 21.

[f] *Syst. Nat.*, ed. X, tom. I, p. 249.

[g] From Aristotle we only learn that Καλλιώνυμος (fair-named) was a shorefish with a large gall-bladder. In the Dragonets the gall-bladder is small, and it seems, therefore, improbable that the name was originally applied to them.

All the species of this genus are salt-water fishes which live alone or in pairs, always keep close to the bottom at a moderate or great depth, do not wander far, and are apparently monogamous. The males, in particular, are adorned with the most beautiful and various colours. The external distinction of sex, which in other fishes in general is only slightly marked, is shown in this genus by a considerable difference of form as well as colour. In the former respect the rule holds good in this case also, that in the males the first dorsal fin is higher, the first ray being considerably elongated; while in this genus the last rays of the second dorsal fin are also elongated, being, as a rule, at least longer than the anterior rays of this fin. The distinction of colour is expressed by the gayer and more brilliant attire of the males. This difference between the sexes led the ichthyologists of a period when little attention had yet been given to this point, to describe as distinct species forms which were really different sexes of the same species. The changes of growth, however, are also considerable; and as the young males are externally very like the females, there was a double cause for this confusion in the nomenclature. It is NEILL whom we have to thank for the first clear elucidation[g] of the sexual characters. The changes of growth in the most common Scandinavian Dragonet were first described by FRIES[h].

The two species which belong to the Scandinavian fauna, may be distinguished as follows:

A:	Base of the anal fin less than $^2/_3$ of the distance from its beginning to the tip of the snout. Second dorsal fin marked with several parallel, coloured, longitudinal bands	*Callionymus lyra.*
B:	Base of the anal fin more than $^2/_3$ of the distance from its beginning to the tip of the snout. Second dorsal fin marked with ocellated, round spots, set in several rows...	*Callionymus maculatus.*

The most common Scandinavian species is

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[a] *Mus. Ad. Frid.*, tom. I, p. 71: *Uranoscopus pictus* (Sw. *Blâstâl*).

[b] *Fn. Suec.*, ed. 1, p. 106.

[c] *Pisc. Mar.*, lib. X, cap. XII.

[d] *Gen. Pisc.*, p. 49; *Syn.*, p. 77.

[e] *Skand. Fisk.*, ed. 1, p. 94.

[f] MÜLLER, however, supposes (*Zool. Dan.* I, No. 36, p. 91) that the Dano-Norwegian name *Flojfisk*, which has given rise to PONTOPPIDAN's description of the flight of the Dragonet, is derived, not from *flyve* (to fly), but from *floy* (vane, pendant).

[g] Mem. Wern. Nat. Hist. Soc., vol. I (1808–1810), p. 529.

[h] Vet.-Akad. Handl. 1837, p. 39.

THE GEMMEOUS DRAGONET (SW. SJÖKOCKEN.)

CALLIONYMUS LYRA.

Plate XIV.

Length of the head from the front point of the intermaxillary bones, when retruded, to the hind branchiostegal margin[a], *which is hidden by the skin, more than 24 % of the length of the body, and to the anterior margin of the gill-opening more than 18 % thereof or than $^{3}/_{4}$ of the base of the anal fin. Base of the anal fin less than or equal to $^{1}/_{4}$ of the length of the body, and also less than (or at most equal to) either the length of the head as first given, or the distance between the first dorsal fin and the tip of the snout, and lastly, about 60 (61) % at most of the distance between the beginning of the anal fin and the tip of the snout. Least depth of the tail at least 13 % of the base of the anal fin, and the breadth across the insertions of the ventral fins at least 50 % of the latter. The lateral line runs along the middle of the body. Posterior dorsal fin marked with several coloured bands, running parallel to the direction of the body.*

R. br. 6; *D.* 4 9(8); *A.* 9(8); *P.* 17—20; *V.* $^{1}/_{5}$; *C.* $x+7+x$; Vert. 21[b].

Syn. *Cottus* ossiculo pinnæ dorsalis primo longitudine corporis, J. F. GRON., Act. Soc. Reg. Sc. Ups. 1740, p. 121, tab. VIII; *Uranoscopus* ossiculo primo pinnæ dorsalis primæ longitudine corporis, L. T. GRON., *Mus. Ichth.*, I, p. 23, No. 64 (♂ adult. *Uranoscopus Lyra*, *Cat. Fish. Gron.*, Brit. Mus., ed. GRAY, p. 42) + *Uran.* oss. pr. pin. dors. pr. triunciali, *Mus.*, l. c., No. 65 (♂ jun. = *Uran. Dracunculus*, *Cat.*, l. c.) + *Uran.* oss, pr. pin. dors. pr. unciali, *Mus.*, l. c., p. 21, No. 63, excl. syn. (♀ = *Uran. micropterygius*, *Cat.*, l. c., p. 43).

Uranoscopus pictus, LIN., *Mus. Ad. Fr.*, tom. I, p. 71.

Callionymus Lyra, LIN., *Syst. Nat.*, ed. X, tom. I, p. 249; MÜLL., *Zool. Dan.*, I, No. 36, p. 91 (ed. germ., Leipzig—Dessau), tab. XXVII; RETZ., *Fn. Suec. Lin.*, p. 313; NILSS., *Prodr. Ichth. Scand.*, p. 92; SCHAGERSTRÖM, Vet.-Akad. Handl., 1833, p. 127; CUV., VAL. *Hist. Nat. Poiss.*, vol. XII, p. 266; FR., Vet.-Akad. Handl. 1837, p. 47; ID. et v. WRIGHT, *Skand. Fisk.*, ed. 1, p. 95, tab. 22 et 23; KRØY., *Danm. Fiske*, vol. I, p. 422; NILSS., *Skand. Fn., Fisk.*, p. 212; GTHR, *Cat. Brit. Mus., Fish.*, vol. III, p. 139; COLL., Forh. Vid. Selsk. Christ. 1874, Tillægsh., p. 62; ibid. 1879, No. 1, p. 37; MALM, *Gbgs, Boh. Fn.*, p. 443; WINTH., Naturh. Tidskr. Kbhvn, ser. 3, vol. XII, p. 19; MOR., *Hist. Nat. Poiss. Fr.*, tom. 2, p. 164; DAY, *Fish. G:t Brit., Irel.*, vol. I, p. 174, tab. LIV; LILLJ., *Sv., Norg. Fisk.*, vol. I, p. 648; HANSEN, *Zool. Dan., Fiske*, p. 37, tab. VI, figg. 8 et 9.

Callionymus dracunculus, LIN. (p. p.), *Syst.*, l. c.; NILSS., *Prodr.*, l. c.; CUV., VAL., l. c., p. 274.

Callionymus draculus, MÜLL., *Zool. Dan.*, I, No. 26, p. 65 (ed. cit.); RETZ., l. c.

Obs. Even PALLAS (*Spicilegia Zoologica*, Fasc. VIII, p. 25) and after his time NILSSON (*Prodr.*) and VALENCIENNES (CUV., VAL., l. c.) have expressed the opinion, which according to O. F. MÜLLER has also been current among the Norwegian fishermen, that *Callionymus lyra* and *dracunculus*, as they have been determined in the North European fauna, are only different sexes of the same species. But FRIES was the first to demonstrate on scientific principles that this is really the case (See Vet.-Akad. Handl. 1837).

The males of the Gemmeous Dragonet are much larger than the females. While the former, when full-grown, measure from 25 to 30 cm., most of the females taken are from 20 to 22 cm. long, and neither FRIES nor LILLJEBORG had ever seen a female fully 25 cm. in length. The body is depressed and roundish, tapering posteriorly in a conical form; the belly is broad and flat, and there is a longitudinal depression along the back and also under the tail, which gives the transsection of the body behind the vent a close resemblance to the figure 8 placed horizontally (∞). The greatest breadth of the body, between the preopercular spines, varies between about 18 and 20 %[c] of its length, and the breadth at the end of the anal fin between about 7 and 9 %[d] of the latter. The depth of the body at the base of the ventral fins apparently decreases with age from about 11 to about $7^{1}/_{2}$ % of the length of the body, at the end of the base of the anal fin from about 6 to about $4^{1}/_{2}$ %, and the least depth, just in front of the base of the caudal fin, from 4 to $3^{1}/_{3}$ %.

The head is depressed, but somewhat higher at the middle than the sloping sides, forming a broad triangle, the body being, therefore, broadest at the opercula, and then tapering towards the snout. The frontal line forms a slight downward curve. The snout is rounded to a point, strongly depressed and thin, resembling a labial fold which covers the upper jaw, and underneath which the latter may be drawn in. The margin of the upper jaw, which projects beyond the lower, is formed by the fairly firmly united and somewhat arcuate intermaxillary bones, which form a kind of beak. These bones are furnished with long nasal processes, which slide along the facial bones, and contribute to the marked protrusion of the upper jaw, when the mouth is opened. The latter then acquires a tubular appearance, and is turned obliquely downwards, as we have endeavoured to show in the outline drawing in Plate XIV. The maxillary bones are very small, situated behind the intermaxillaries and hidden by the labiate skin of the snout, their lower end being visible only when the mouth is opened and protruded. Both jaws are furnished with fairly fleshy lips and very small, cardiform teeth. There are no teeth on the palate or on the tongue, which is small, cartilaginous and rounded to a point, with a small, soft rim round the free tip. A small, transverse, membranous fold appears on the palate, but there is no corresponding fold below it. The eyes are set high and close to each other, but are turned in a lateral direction, the eyeballs, which project above the level of the forehead, being superiorly depressed. The pupil is kidney-shaped, there being a lobate process in the upper margin of the iris. The nostrils are very small and are set quite close to the eyes; the anterior opening is somewhat tubular, the posterior almost invisible. At the lower corner of the preoperculum we find a projecting hand-shaped process, which is generally furnished at the end with 3 pointed, subulate spines, directed upwards and backwards, and inferiorly with a spine pointing forward, which lies, however, along the base of the process, hidden by the skin, and is therefore easily overlooked. The fish is not unskilled in the use of these weapons. When an attempt is made to lift it, it expands the gill-covers, like the Bullheads, the spinous processes being thus erected. The operculum is small and very thin, with soft, cartilaginous margin. The gill-openings are small round holes on each side of the occiput, with a thin, loose membrane at the margin, which closes them like a valve. The remainder of the opercular margin is united to the body by the skin. The branchiostegal membrane is furnished with 6 rays, all fine and soft, with hairlike tips, the uppermost three being especially long and bent round the opercular margin. The branchial cavity is narrow, with small gills and narrow openings between the arches; the anterior margins of the latter are furnished with two rows of small, verrucose, osseous protuberances (gill-rakers). The upper pharyngeals are loosely united into two rounded almond-shaped plates, entirely rough with fine, cardiform teeth. The lower pharyngeals are of the ordinary oblong shape, and are armed in the same way.

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[a] This is formed by the upturned branchiostegal ray which extends farthest back, and which is generally the most prominent posterior boundary of the head. The hind margin of the gill-cover is formed by the suboperculum, which is, however, hidden by the skin, and sometimes indistinct. The most trustworthy measurement of the length of the head, in order to determine this species, is that taken to the anterior margin of the gill-opening.

[b] In young specimens according to MALM, 19 or 20, 6 of which are abdominal. In old specimens the number of the latter is 7 or 8.

[c] The least proportion we have found in 6 specimens, varying in length between 53 and 237 mm., is 17·7 %, the greatest 19·6 %.

[d] The least proportion we have found in the above specimens, is 6·8 %, the greatest 8·6 %.

The skin of the body is throughout thin and smooth, without any trace of scales, and covered with an abundant mucous secretion. At several spots it is so loosely attached to the body that it may be raised into folds. The lateral line is scarcely visible, but runs in the form of a somewhat raised seam along the middle of the sides, its course being fairly straight, though somewhat winding. It advances out to the hind margin of the caudal fin, lying between the third and fourth rays thereof. Straight across the occiput there runs a connecting-duct between the two lateral lines. On the hind part of the body, from the middle of the second dorsal fin, we generally find transverse branches of the lateral line, alternately in an upward and a downward direction, one running straight up, and the next, which is shorter, obliquely downwards. One or two such branches rise from the lateral line on each side, meeting at the dorsal edge, just in front of the caudal fin, and thus forming connecting ducts. The vent is situated in front of the middle of the body, almost vertically below the second ray of the second dorsal fin.

Two dorsal fins rise from the depression which runs along the dorsal edge. The anterior is triangular, and begins above the upper angle of the base of the pectoral fin, at a distance from the middle of the point of the intermaxillary bones, when drawn back, which measures from 25 to 28 % of the length of the body. It contains only four, simple, soft-tipped rays, which are followed by the fin-membrane out to the very tip. The first ray is the longest, the others gradually diminishing in length. The second dorsal fin, which begins near the end of the first, generally contains eight[a] simple rays, all of which are articulated, and at the end one ray branched down to the base, and with the branches also divided at the tip. The length of its base decreases with age from about 26 to 23 % of the length of the body. The anal fin is of the same shape and structure as the second dorsal, but begins a little farther back than the latter, the distance between it and the tip of the snout being from about 43 to 41 % of the length of the body, and also ends a little behind the termination of the second dorsal fin. The length of its base varies between 26 and 23 % of that of the body.

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[a] Sometimes only 7.

The shape of the pectoral fins, when expanded, is almost rhomboid, at other times lanceolate, though somewhat broad; and their points extend a little beyond the vent. Their base is long. They contain one simple ray and from 17 to 19 branched at the tip. When the total number of rays is 18, the eighth is the longest, when it is 19, the eighth and ninth are equal in length and longest, and when 20, the ninth ray is the longest. These rays are very distinct, though fine, and are united by a thin membrane.

The ventral fins, which are set far apart, in a horizontal position, somewhat in front of the base of the pectoral fins, are united to the anterior side of the latter by the fin-membrane. They contain one simple ray and five repeatedly branched at the tip and thick at the base. The simple ray is very small and closely united to the second; the others gradually increase in length, the last ray being the longest or, at least, of the same length as the next to it, and extending to the vent or, in old males, even to the beginning of the anal fin. The relative length of these fins decreases, however, with increasing age from about $22^{1}/_{2}$ to 19 % of the length of the body. The breadth of the pelvis across their base, on the other hand, shows even relative increase with age, varying between about $12^{1}/_{2}$ and $14^{1}/_{2}$ % of the length of the body, and being greatest in the females.

The caudal fin is long and rounded at the end, its length, in the females and young specimens, being about 19 or 20 % of that of the body, greatest in the males, in which, according to Kroyer, it may rise as high as 25 % thereof. It is composed of seven middle, bifid rays and a varying, but comparatively small, number of supporting rays on each side. The number of the latter is generally 3, this being most often the case at the lower margin, but at the upper margin in particular it varies between 1 and 4.

The remainder of the external sexual distinctions are as follows:

1. *Old male* (Plate XIV, fig. ♂). Head more elongated, obovate, its length from the margin of the upper jaw, when drawn back, to either of the gill-openings being about 23 % of that of the body. Snout also long, its length being about equal to the distance between the hind margin of the gill-cover and that of the eye or about 13 or 14 % of the length of the body, the eyes being thus set behind the middle of the head. The two dorsal fins contiguous at the base. The anterior rises in a falciform shape to a considerable height, which may be more than half the length of the body, the tip of the fin, when depressed, extending beyond the base of the caudal fin. The tip is formed, however, entirely by the first ray, which is the longest, being nearly twice as long as the second, three times as long as the third, and seven times as long as the fourth. In the second dorsal fin, the height of which is only $^{1}/_{3}$ of that of the first, the middle rays are somewhat shorter than the anterior, which in their turn are shorter than the last ray, which is the longest, and, when erected, points obliquely in a backward direction. The upper margin of the fin is thus as it were incised, and the posterior part of the fin is so high that, when depressed, this fin also extends beyond the base of the caudal fin. The anal fin is also much higher behind than in front, the last ray being so long that the points of its branches extend beyond the base of the caudal fin. The caudal fin is of nearly the same length as the head, and the other fins are also larger than in the females. Behind the vent we find a long, conical papilla.

The colouring is above yellowish brown and below yellowish, the belly being white with a dash of yellow. Along the sides there run two handsome, azure bands, separated by a somewhat broader, greenish stripe. The upper of these blue bands is generally broken up anteriorly into spots. Above these bands we find a longitudinal row of bright green spots, which are continued on the head across the gill-cover, and mingled with the handsome, blue and violet spots and short, irregular stripes which adorn the sides of the head and a part of the snout. The lips are also alternately violet and blue. Iris bright green, with a fairly broad, brown stripe above and below the pupil, which often has a bluish lustre. First dorsal fin bright yellow, with three, small, oval, light gridelin spots edged with blue, at the base, one between each pair of rays, and a wavy band of the same colour and edged in the same way, running from these spots and following each mesial line of the membrane between the first three rays. Second dorsal fin marked with several bands, successively green, yellow and light blue, and running transversely across the fin (i. e. in the direction of the body), three of them being generally continuous and edged with a darker blue, and one broken up into spots, running nearest the upper margin of the fin. These bands begin at the first ray in the form of large, extended spots, advance in a somewhat winding course, and posteriorly bend upwards, towards the upper margin of the fin. The lowest ones are the darkest, the others growing gradually lighter in colour the nearer they approach the margin of the fin. Caudal fin green at the base, shading into yellow towards the hind margin, and marked with irregular, longitudinal, interrupted bands, which are blue at the base of the fin and violet at the margin. Anal fin of a uniform drab, but in certain lights shading into a handsome violet. Ventral fins yellow at the base and green at the tip, marked with a varying number of handsome blue spots. Pectoral fins of a lighter yellowish gray, marked with spots forming transverse bands of several colours across the rays, and with a few, bright blue spots at the base of the latter.

This description is generally true of the coloration of the males, which is subject, however, to innumerable individual variations. It is seldom that we find all the parts of an individual specimen equally perfect in colour; now one part comes out, and now another, seemingly at the expense of the others. The beautiful colours which adorn this fish during life, are also highly evanescent, and in most cases rapidly disappear after death.

2. *Female* (Plate XIV, figs. ♀). Head short and triangular, with pointed snout. In a female, 235 mm. long, the head measures about 18 % of the length of the body, in another, 185 mm. long, 20 % thereof. Eyes set about half-way along the head. Length of the snout in old specimens about 9 or 10 % of that of the body, in young $7^1/_2$ or 7 %, and always less than the distance between the anterior margin of the eye and the gill-opening, or than the distance between the posterior margin of the eye and the margin of the operculum. Dorsal fins some distance apart at the base, and their mutual relation in respect to height the contrary of that existing in the males, the first being not only lower than the second, but so low that the first and longest ray measures only $^1/_{10}$ of the length of the body. The tip of this ray, when depressed, extends only to the base of the first ray of the second dorsal fin. The anterior rays of the latter are longer than the last ray, the branches of which, when depressed, do not extend to the base of the caudal fin. The last ray of the anal fin is somewhat longer than the first, but, when depressed, falls far short of the base of the caudal fin. Behind the vent there is only a rudiment of the conical papilla.

The whole of the upper part of the body, above the lateral line, and the head are of a yellowish brown colour, marbled with greenish spots of varying size and shape and brown dots. The spots are encircled by dark brown rings, which at certain points coalesce, assume a darker colour, and form as it were faintly traced transverse bands across the back. The usual number of these transverse bands is three, the first, which is also the narrowest, being situated at the beginning of the second dorsal fin, the second, which is also the broadest and most distinct, at the end of this fin, and the third just in front of the base of the caudal fin. Sides below the lateral line whitish and semi-transparent, with a few, large and scattered, brown (sometimes blackish brown) spots, which are arranged in two somewhat irregular rows and surrounded by a broad strip of bright, brassy yellow. Belly milk-white, and the lower part of the tail as clear as water and almost transparent. Along the lateral line a dark brown, broken streak. Iris with a narrow, golden ring round the pupil, which is black, shading into blue. First ray of the first dorsal fin yellowish brown, with a few greenish transverse bands, and the membrane uniting the last three rays deep black and covered, as it were, with a net of fine, dense, brownish yellow veins. This singular marking is peculiar to the female and highly characteristic. Second dorsal fin marked with three brown bands, which are often interrupted, the first along the base of the fin, the second, which is the broadest and most distinct, along the middle of the fin, and the third at the margin. Between them two other, faint, bluish bands may be traced. The rays of this fin are whitish and transparent, the first being marked with several brown transverse bands, the second with only three at the tip, the next rays with two and the last rays with only one. Anal fin of a uniform, whitish, almost milky colour. Ventral fins of the ground-colour of the body, with a few irregular, brown spots, interspersed with one or two of bluish green. Membrane of the pectoral fins pale gray and transparent, and the rays spotted alternately with yellow and brown, these spots forming broken transverse bands across the fins. Caudal fin with yellowish rays and three large, indistinct, light brown, transverse bands, strewn with spots of a darker brown, which on the lower part of the fin becomes almost black. The lowest ray is entirely white, and the next to the lowest white at the tip.

3. *Young male.* When very young, the male is extremely like the female; and until FRIES's time the two sexes of this species in their juvenile stage were confused by most ichthyologists who had not examined the internal sexual organs. The same colour, the same short head, the same relative size of the parts of the body meet us in the young males as in the females. The only external point by which we can always recognise the young male, is the somewhat greater height of the first dorsal fin, which is always somewhat higher at least than the second dorsal, and always without the black colour between the rays. But as it grows, the young male has less and less of the appearance of the female, and gradually adopts the shape and dress which belong to the full-grown male. This transition may be illustrated most clearly by a comparison between young males of different sizes. Let us choose four specimens, the first 163 mm. in length, the second 179, the third 197 and the fourth 222. In the first the length of the head to the occiput is not quite $^1/_5$ of the length of the body, in the second exactly $^1/_5$. In both the relative length of the snout is the same as in the full-grown female. In the third specimen the length of the head is somewhat more than $^1/_5$ of that of the body, and the distance between the tip of the upper jaw and the eye is equal to that between the anterior margin of the eye and the gill-opening, but less than that between the posterior margin of the eye and the margin of the operculum. In the fourth specimen the length of the head is still greater in proportion to that of the body, and the length of the snout is very nearly as great as in the full-grown male. In the first specimen the first ray of the first dorsal fin measures less than $^1/_4$ of the length of the body, but in the fourth specimen more than $^1/_3$ thereof. In the first specimen the tip of this ray, when depressed, extends to the tip of the first ray of the second dorsal fin, in the second specimen to the tip of the fourth ray of the latter fin, and in the fourth specimen to the tip of the sixth ray thereof. In the first three specimens the two dorsal fins are still separated at the base, as in the full-grown female, in the fourth, on the other hand, they are almost united. In none of these specimens does the last ray either of the second dorsal fin or of the anal, when the fin is depressed, yet extend to the base of the caudal fin, but the distance gradually decreases from the first specimen to the fourth.

The coloration of all four is most like that of the female, but here and there in the first two specimens, and still more frequently in the fourth, we find something of the dress of the older males.

We have never found a single young male during the spawning-season with the sexual organs fully developed; and we therefore conclude that all of those which have the colouring and the external characters described above, are not yet capable of propagating their species. They probably do not possess this power until the first dorsal fin (taken as an example of the general development) has attained the length it possesses in the old males. However, as we used the length of the body to express a comparison between the specimens, it may not be superfluous to remark that the length of the fish cannot always be regarded as a trustworthy measure of its age. Among numerous individual exceptions we have found a male fully developed, but only 200 mm. in length.

On examination of the intestines as they lie in the abdominal cavity we find an unmistakable resemblance between the Gemmeous Dragonet and the Bullheads. The intestinal canal is fairly long. The stomach, which is without any trace of pyloric appendages, appears only as an expansion of the intestine. The intestine proper forms several bends, and has extremely thin walls. The liver, which is of a nankeen-yellow, consists of one single piece, without true lobes. It lies principally to the right, and partly envelops the first bend of the intestine. The gall-bladder is small and oblong, and lies in an incision in the liver. The air-bladder is wanting. The kidneys are triangular, and lie with the broad end in front, posteriorly tapering to a point. The urinary bladder is large, clear, thin-walled and obovate. The peritoneum is white and shiny. The ovaries are united behind, but distinct in front. The testicles are oblong and distinct, and in the young male are externally much the same as in certain birds. They are situated somewhat behind the middle of the abdominal cavity.

Of the peculiarities of the skeleton we shall remark only the absence of the subcranial tube (for the optic muscles); the partition wall between the orbits, on the other hand, is ossified to a great extent, at least in front (*os orbitosphenoideum*), though thin. The operculum and preoperculum are considerably reduced, the latter consisting almost entirely of the above-mentioned spinous process, and the former resembling a scalene triangle, with its articulation with the hyomandibular bone at the obtuse angle, and with the suboperculum, which is large and far more like the ordinary operculum in shape, attached to the longest side. The suboperculum thus forms the entire hind margin of the gill-cover.

The Gemmeous Dragonet occurs along the whole west coast of Europe, from the south of Spain[a] as far north at least as the neighbourhood of Trondhjem. It also enters the Sound, where it was observed in 1743 by LINNÆUS. It is, however, very rare there, of somewhat more frequent occurrence off Kullen, and still more common on the coasts of Bohuslän and Norway. It is nowhere found, however, in large numbers, only solitary individuals being taken during the fishery for some other species, notably the Herring. Not a single exception to this rule has been observed even during the spawning-season, whence it seems highly probable that this fish always lives alone or in pairs. The entire form of the body shows that it is a bottom-fish of sluggish temperament and slow in its movements; and the knowledge we possess of its manner of life, confirms this impression. It prefers deep water — the Royal Museum has obtained from the fishermen on the Jutland Reef a female 168 mm. long, taken at a depth of between 100 and 200 fathoms — and probably a soft bottom. It is usually only during the spawning-season, which occurs in November and December, that it approaches the shore, and it is most often taken at this period. In Sweden the females are much rarer than the males[b].

Several inductions drawn partly from its manner of life and partly from its structure, lead us to believe that this fish is monogamous. SAVILLE-KENT[c], who had witnessed the operation of spawning in an aquarium, writes as follows: "At such times the male, resplendent in his bridal livery, swims leisurely round the female, who is reclining on the sand, his opercula abnormally distended, his glittering dorsal fin erect, and his every effort being concentrated upon the endeavour to attract the attention and fascinate the affections of his future mate, much after that manner of courting commonly pursued by the male birds of the Pheasant family and Callinaceæ usually termed "strewing". The female, at first indifferent, becomes at length evidently dazzled by his resplendent attire and the persistency of his wooing, she rises to meet him, the pair — so far as such a course is practicable with fishes — rush into each other's arms, and, with their ventral areas closely applied, ascend perpendicularly towards the surface of the water. In connection with these manœuvres, it may safely be predicated that the ova are extruded and fertilised, but in the limited depth of water of an aquarium tank, the matrimonial tour cannot, apparently, be sufficiently prolonged to assure the consummation of this act; the fish after reaching the surface being projected by their previously gained impetus slightly above the water, when, falling apart, they sink slowly to the bottom, and the process after short intervals is repeated."

The Dragonets are extraordinarily tenacious of life in comparison with other salt-water fishes, and can preserve life for lengthy periods out of the water. Their closely covered gill-openings, which help the gills to retain their moisture, and protect them against the effects of immediate contact with the atmosphere, are especially conducive to this result. In spite of its phlegmatic temperament the Dragonet is by no means clumsy in its movements. "In its resting-place on the bottom," says COUCH[d], "the size and position of its ventral fins afford it support, while, by a very slight motion in them, it is able to raise itself in an instant for escape, or to seize any object it wishes to devour." Of the females and young males, which, it is stated, sometimes seek shelter by burying themselves in the sand at the bottom[e], COUCH remarks, according to YARRELL[f]: "They keep at the bottom, among sand or stones, and never rise but to pass from one station to another, which is done with great suddenness and rapidity. They possess great quickness of sight, and dart with swiftness when alarmed, though not to a great distance; and I have seen the Sordid Skulpin repeatedly mount after prey, and invariably return to the same spot again." The Dragonets live on small prey, which may be easily seized. In the stomach we generally find several kinds of small crustaceans and univalves, and the thin intestinal canal is crammed with the crushed shells of these animals.

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[a] STEINDACHNER, Stzber. K. K. Akad. Wiss. Wien, LVII (1868), I, p. 416.

[b] It does not seem to occur in the Mediterranean. Cf. NINNI, *Atti Ist. Venet.*, ser. 5, tom. 4, p. 1049.

[c] *Brit. Mar., Freshw. Fish.*, Handb. Gt. Intern. Fish. Exhib. London 1883.

[d] *Hist. Fish. Brit. Isl.*, vol. II, p. 175.

[e] L. c., p. 178.

[f] *Brit. Fish.*, ed. 2, vol. I, p. 303.

As the Dragonets belong to the species despised by the fishermen, there is no particular method of fishing for them: and the few specimens that are accidentally taken, are thrown away. For all this, their flesh is very fine, white and agreeable, and would, without doubt, furnish an appetising dish, if sent to table. Occasionally, though seldom, a specimen or two may be taken on the hook during summer, but most of the catches are made in nets or large Herring-seines.

(Fries. Smitt.)

THE LESSER DRAGONET.

CALLIONYMUS MACULATUS.

Plate XV, fig. 1.

Length of the head from the front point of the intermaxillary bones, when retruded, to the hind branchial margin[a], *which is hidden by the skin, less than 24 % of the length of the body, and to the anterior margin of the gill-opening less than 18 % thereof or than $^2/_3$ of the base of the anal fin. Base of the anal fin more than 26 % of the length of the body, and also more than either the length of the head as first given, or the distance between the first dorsal fin and the tip of the snout, and lastly at least about 70 % of the distance between the anal fin and the tip of the snout. Least depth of the tail at most about 12 % of the length of the base of the anal fin, and the breadth across the insertions of the ventral fins at most about 47 % of the latter. Course of the lateral line considerably above the middle of the sides. Posterior dorsal fin marked with ocellated round spots, set in several transverse rows.*

R. br. 6: *D.* 4 9(8): *A.* 9: *P.* 18 l. 19: *V.* $^1/_5$: *C.* $x + 7 + x$.

Syn. *Dracunculus*, Willughby, *Hist. Pisc.*, lib. IV, cap. XXV; Ray, *Syn. Meth. Pisc.*, p. 79; nec Rondelet.

Callionymus dracunculus, Brünn., *Ichthyol. Massil.*, p. 17: Schagerstr., Vet.-Akad. Handl. 1833, p. 133, tab. I, figs 1—3 (nec synon., nec fig. 4).

Callionymus maculatus, Raf., *Caratt.*, p. 25, sp. 60, tab. V, fig. 1; Bp., *Icon. Fn. Ital.*, tom. III (*Pesci*), No. 104, tav., figs 2 et 3, fasc. III; Fr., Vet.-Akad. Handl. 1837, p. 48; Id. et v. Wright, *Skand. Fisk.*, ed. I, p. 102, tab. 24; Kr., *Danm. Fiske*, vol. 1, p. 442; Nilss., *Skand. Fn.*, *Fisk.*, p. 216; Gthr, *Cat. Brit. Mus.*, *Fish.*, vol. III, p. 144; Canestr., Arch. Zool., Anat., Fisiol., vol. II, p. 110, tab. 1, fig. 2; Gthr, Ann., Mag., Nat. Hist., ser. 3, vol. 20, p. 290, tab. V, fig. A; Steind., Stzber. Akad. Wiss. Wien, LVII (1868), I, p. 416; Coll., Forh. Vid. Selsk. Christ., 1874, Tillægsh., p. 62; Malm, *Gbgs, Boh. Fn.*, p. 444; Mor., *Hist. Nat. Poiss.*, *Fr.*, tom. II, p. 169; Day, *Fish. Gr. Brit.*. *Irel.*, vol. I, p. 177, tab. LIII, fig. 5; Lillj., *Sv.*, *Norg. Fn.*, *Fisk.*, vol. 1, p. 666.

Callionymus lyra, Risso, *Ichth. Nice*, p. 113; *Eur. Mér.*, vol. III, p. 262. *Call. cithara* + *Call. reticulatus*, Cuv., Val., *Hist. Nat. Poiss.*, vol. XII, pp. 280 et 284.

Obs. Though the oldest post-Linnæan name of the species is *dracunculus*, and though Brünnich's description is conclusive proof of his having correctly understood the difference between this species and the preceding one, still the reiterated misuse of the name *dracunculus* in previous writers seems to render it advisable to let this name drop. Schagerström does not quote Brünnich as his authority, but grounds his opinion on those of his predecessors who have wrongly described the female of *Call. lyra* as a distinct species, under the name of *Call. dracunculus*; and in Schagerström *dracunculus*, which in Linnæus etc. was a half-species, so to speak, becomes a double species, for he describes and figures a young female of *lyra* as a specimen of the former. The original of his fig. 4 is preserved in the Royal Museum, and, as Lilljeborg has also remarked, is a female of the preceding species. This is also shown by the measurements which Schagerström has given in his description, of the length of the head and the caudal fin, and of the distance between the anal fin and the point of the chin, as well as by his description of the colouring of the second dorsal fin, though the correctness of these characters can no longer be tested by an examination of the specimen, the body of which has once been dried until hard and bent. Fries had no opportunity of examining this specimen, which did not come into the possession of the Royal Museum until 1851, when it was bequeathed to the collections by Schagerström; but in the first edition of "Scandinavian Fishes" he writes: "to judge by the description it must have been an ordinary female specimen of *C. lyra*."

"In a genus so natural as *Callionymus*," writes Fries in the Transactions of the Swedish Academy of Science for 1837, "where the difference between the sexes is also so considerable, and the relative size of the parts of the body so subject to changes of growth, the diagnosis of the species must always be fraught with difficulty. To judge by the relations between the two northern species, we must have recourse to the evanescent coloration, if it be necessary that the *differentia specifica* shall embrace both sexes as well as the younger specimens." The attempt we have made in the above diagnosis to range by side of the most constant chromatic character the tenable characters of form, is based on a comparison between six specimens of the preceding species and five of the species now under consideration. With a more abundant supply of materials for examination in the case of *Callionymus maculatus*, of which we have examined only one female, we may find some exceptions to these characters, the general validity of which appears, however, from the following table:

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[a] See p. 273, note *a*.

	Callionymus maculatus.					*Callionymus lyra.*					
	The Skaw, 17 fths., blue clay bottom. THÉEL and TRYBOM, 1878.	Bohuslän. FRIES, November 1836.	Strömstad Fjord. C. A. HANSSON, August 1880.	The Sound. SCHAGERSTRÖM, July 1830.	Bohuslän. A. H. MALM, 1882.	Gullmar Fjord. S. LOVÉN, 1859.	Skelder Bay. THÉEL and TRYBOM, July, 1878.	From the old collections of the Royal Museum. Locality not specified.	Jutland Reef, 100—200 fathoms, 1880.	Bohuslän. FRIES, July, 1835.	Bohuslän. FRIES, July, 1835.
	♀	♂	♂	♂	♂	♂	♀	♀	♀	♂	♂
Length of the body expressed in millimetres	61	102	111	138	146	53	83	163	168	191	237
Length of the head to the hind branchiostegal margin in % of the length of the body	22.9	22.3	22.5	22.4	21.2	26.8	25.0	26.3	26.8	26.2	28.9
,, ,, ,, ,, ,, ,, gill-opening ,, ,, ,, ,, ,, ,, ,, ,,	17.2	16.7	17.1	15.2	14.4	19.8	18.9	19.4	20.2	20.4	23.2
,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, base of the anal fin	62.5	60.0	60.3	55.2	54.4	79.5	77.3	84.8	83.0	86.7	94.1
Base of the anal fin in % of the length of the body	27.5	28.0	28.4	27.5	26.4	25.0	24.4	23.0	24.4	23.5	25.0
Distance between the first dorsal fin and the tip of the snout in % of the length of the body	24.6	22.3	22.0	20.3	20.2	26.4	25.5	26.2	27.1	27.7	27.5
Base of the anal fin in % of the distance between it and the tip of the snout	70.0	75.0	81.2	80.0	80.4	57.4	60.0	56.0	60.4	56.6	60.8
Least depth of the tail in % of the base of the anal fin	11.9	12.3	11.1	12.6	12,4	15.9	15.7	14.7	16.0	15.1	13.5
Breadth across the insertions of the ventral fins in % of the base of the anal fin	46.6	46.7	38.7	42.1	41.4	50.0	51.7	62.1	56.0	61.1	54.2
Length of the caudal fin in % of the distance between the first dorsal fin and the tip of the snout	83.3	88.5	100.0	117.0	117.8	71.4	75.5	79.4	72.5	70.0	78.4
Length of the snout in % of the length of the body	6.7	6.8	7.2	7.2	6.8	7.5	7.8	9.1	10.1	9.6	13,6
Longitudinal diameter of the eye in % of the length of the snout	97.6	85.7	87.5	80.0	80.0	90.0	86.1	63.3	54.7	54.0	43.8
Breadth of the head across the preopercular spines in % of the length of the body	16.4	16.7	13.5	14.5	13.7	18.3	18.1	17.7	19.6	17.8	18.1
Depth of the body at the insertion of the ventral fins ,, ,, ,, ,, ,, ,, ,, ,,	9.8	7.8	8.1	8.3	7.5	10.4	10.8	7.6	9.5	9.4	8.8
Length of the 1st ray of the 1st dorsal fin ,, ,, ,, ,, ,, ,, ,, ,,	9.3	24.8	52.2	37.7	37.0	9.0	10.2	10.1	9.2	24.8	60.8
,, ,, ,, ,, ,, ,, ,, 2nd ,, ,, ,, ,, ,, ,, ,, ,, ,, ,,	15.4	23.4	29.3	31.5	29.0	13.2	15.6	14.3	13.1	13.8	14.0
Base of the second dorsal fin ,, ,, ,, ,, ,, ,, ,, ,,	21.3	26.5	27.0	25.4	25.3	25.1	26.1	23.3	23.2	23.0	24.0
Length of the pectoral fins ,, ,, ,, ,, ,, ,, ,, ,,	18.5	17.1	17.1	16.7	18.8	18.1	17.8	17.7	19.0	16.3	16.0
,, ,, ,, ventral ,, ,, ,, ,, ,, ,, ,, ,, ,,	21.3	18.6	20.0	18.1	19.4	22.6	21.4	20.2	19.8	19.1	19.0
Distance between the ventral fins and the tip of the snout ,, ,, ,, ,, ,, ,, ,, ,,	18.8	17.6	17.1	17.4	16.6	21.3	18.0	20.2	20.0	21.0	21.9

This table also shows the most important changes of growth and sexual differences. The most distinct and remarkable instances of the former are expressed in the proportion between the length of the head to the gill-opening and that of the body. This proportion sinks in *Callionymus maculatus*, but rises in *Call. lyra*, the two species thus showing different directions of development, and being most closely allied during youth. The sexual difference which appears in the distance between the ventral fins and the tip of the snout, and which in *Call. lyra* is less in the female than in the male, also seems to show that the female characters have fixed the direction of development in *Callionymus maculatus*, and the male characters in *Call. lyra*. This seems to be also the case with the average height of the second dorsal fin, which in *Callionymus lyra* is relatively greater in the female than in the male (with the exception of the last ray), and is generally greater in *Call. maculatus* than in *Call. lyra*, though the females of both species are much alike in this respect.

With these exceptions we can find no remarkable difference, in the form, the position of the parts of the body, or the number of the fin-rays, between this species and the Gemmeous Dragonet; and we may therefore refer the reader to the description of the latter species. In the colour and the markings, however, there appear considerable differences between the two species; and it is by these characters that we may most easily distinguish between them. The male which FRIES and v. WRIGHT obtained in Bohuslän, and which they kept alive for some time under their own observation, is thus described by the former:

"Above greenish yellow, and below a very pale flame-yellow. The whole of the back and the upper part of the head thickly strewn with small, irregular, ferruginous spots of different size and shape. Along the sides of the body a few irregular rows of round spots, partly light blue and partly blackish brown, most of them being surrounded by a greenish ring. Lips and the sides of the gill-cover with a few short, light blue bands and large spots. Iris greenish, with a light flame-yellow ring, darker in the middle, next the pupil, which is tinged with blue. First dorsal fin of a very light, grayish colour, with somewhat darker rays, each ending in a snow-white tip. On the membrane between the first three rays three, dark green spots, one above another, and between them two others, which are snow-white; two more spots of a snow-white colour surround the hind margin of the middle dark green spot; between each pair of rays in the rest of the fin two dark green spots, the upper oblong and elongated into a point, and two, very small, round, snow-white spots; behind the fourth ray only one spot of each colour. Second dorsal fin very light and transparent, changing colour according to the background on which it appears. On this fin four transverse rows of round, green spots, containing a darker centre; the lowest row the darkest, the others becoming gradually lighter as they approach the upper margin of the fin; these spots are so arranged that one spot in each row lies between each pair of rays. But besides these fairly distinct, ocellated spots we find five rows of more indistinct, snow-white spots, each encircled by a yellow ring, the lowest four rows being in a line with the green spots, there being a white spot in front of each of the latter. The fifth row lies close to the upper margin of the fin, and contains the most distinct rings, but only a slight trace of the green, ocellated spots. Anal fin without spots, whitish at the base and shading into violet towards the margin. Caudal fin whitish, with scattered, ferruginous spots at the base, yellowish, longitudinal spots in the middle, and light blue spots along the tip. Pectoral fins whitish, shading into yellow, with yellow rays, marked with russet spots, which form broken transverse bands across the fins. At the base of these fins a few, blackish brown, round spots and light blue streaks. Ventral fins flame-yellow at the base, a handsome light green towards the tip, and blue at the margin. At the base of these fins some small, round, scattered, snow-white, ocellated spots."

The coloration of the female, according to BONAPARTE, is essentially the same; but in the females of this species, as in those of the preceding one, the hind part, at least, of the membrane of the first dorsal fin is black.

The Lesser Dragonet is one of the rarest Scandinavian species. In the Mediterranean, which is probably its true home, it is all the commoner[a]. In recent times (1867) a specimen was taken by GWYN JEFFREYS[b] off the Hebrides, at a depth of 80 or 90 fathoms. Up to that time it was a notable peculiarity that this Mediterranean species should also belong to the Scandinavian fauna. About 1830 it was found in the Sound, off Landskrona, by Dr. SCHAGERSTRÖM, and in Gullmar Fjord, off Fiskebäckskil, by Professor FRIES. The three specimens from the neighbourhood of Bergen which have been presented by Governor CHRISTIE to Bergen Museum, probably date from the same period. All these specimens were males. There is no subsequent record of its occurrence in Norway, though it has several times been found in the Skager Rack. Professor MALM obtained two male specimens in Bohuslän, the one 95 mm. in length, and taken at the entrance of Gullmar Fjord (3rd Aug., 1863), and the second 125 mm. in length, and taken at a depth of 16 fathoms, off Vinga near Gothenburg (2nd June, 1873). During the voyage of the gunboat *Gunhild*, in July, 1878, Dr. THÉEL and Dr. TRYBOM took three specimens, two males and one female, between 60 and 70 mm. long, on a clayey bottom at a depth of from 17 to 30 fathoms, between the Skaw and the Nidingen Islands. Mr. C. A. HANSSON has forwarded to the Royal Museum a male 111 mm. long, from Strömstad Fjord, where it was taken at a depth of 30 fathoms, on the 23rd of August, 1880; and in 1882 Dr. A. H. MALM forwarded from Bohuslän the largest example of this species yet discovered, a male 146 mm. in length. A female 99 mm. long, the largest on record, and described by Professor LILLJEBORG as having "fairly large, though not ripe, eggs", was taken in July, 1883, by Professor

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[a] BONAPARTE, l. c.; STEINDACHNER, l. c. GIGLIOLI, *Espoz. Intern. di Pesca in Berlino 1880. Sez. Ital., Cat.*, p. 90; MOREAU, l. c.

[b] GTHR. Ann. Mag. Nat. Hist., l. c.

TULLBERG and Dr. THÉEL, in a trawl, at a depth of 30 or 40 fathoms in Gullmar Fjord. No more northern or Atlantic specimens are known, and MOREAU states emphatically that the species is unknown on the west coast of France. It is probably a deep-sea fish, too difficult to obtain with ordinary tackle, or despised for its small size by the fishermen.

We have every reason to suppose that the habits of the Lesser Dragonet are almost, if not entirely, the same as those of the preceding species. However, we have no trustworthy information as yet on this point. The specimen described by FRIES was taken in a large Herring-seine, together with several specimens of the Gemmeous Dragonet and a great quantity of small Herrings. Most of the other examples were taken in a dredge or trawl. MALM's specimen from Vinga had become entangled in a Flounder-net.

(FRIES, SMITT.)

FAM. **CYCLOPTERIDÆ.**

Body more or less tadpole-like or bulky (with short caudal part), anteriorly terete and posteriorly compressed. Dorsal fin normal or with the anterior part reduced or overgrown, composed of flexible, but anteriorly unarticulated rays, continuous or divided into two parts. Anal fin in structure and extent analogous to the posterior part of the dorsal fin. The rays of the ventral fins, six in each fin, form the framework of a fleshy sucking-disk. Pectoral fins broad, with the base projecting downwards in front of the ventral sucking-disk. Gill-openings small or narrow. Fourth branchial arch with only one row of lamellæ, the gill-slit behind it wanting. Six branchiostegal rays. Air-bladder wanting. Pyloric appendages numerous. Suborbital ring united to the preoperculum by an osseous or cartilaginous connexion. No palatine or vomerine teeth.

Like the Dragonets — by the form of the body and the spinous armour of the preoperculum — the *Cyclopteridæ* are also ranged by the form of the body, and further by the broad pectoral fins and the catilaginous or bony bridge on the cheeks, beside the Cottoid type, and may be regarded as Cottiform Gobioids. Their place among the Acanthopterygians is a low one, for the skeleton is only slightly ossified or even cartilaginous, and the spinous-rayed parts of the fins are but little developed. The scales are also few and irregular, entirely wanting or replaced by scattered tuberculated plates or spines on the skin. The jaw-teeth, on the other hand, are numerous, though weak, being cardiform and simple or tricuspid. The most singular character of these fishes, and the one most closely connected with their manner of life, however, is the metamorphosis of the ventral fins into an adhesive dish, by means of which the Cyclopteroids attach themselves to stones or other hard objects at the bottom of the sea. In this round or somewhat oblong disk we find a ring composed generally of 13 distinct, fleshy protuberances, the first unpaired, each of the other belonging to one of the rays of the ventral fins; and around this ring there is a dermal border.

The family, which was referred by CUVIER to the Malacopterygians, in his writings bears the name of *Discoboles*[a], but also includes the following family. BONAPARTE[b] held the same opinion, but changed the name of the family to *Cyclopteridæ*. RISSO was in all probability the first to suspect the connexion between these fishes and the Gobiomorphs[c]; but MÜLLER (l. c.) the first to discover in this connexion their true Acanthopterygian nature. It was GÜNTHER[d] who reduced the family to its present limits. These are by no means extensive; for though 24 species, all of northern origin, have been described, and distributed among 5 genera, both these numbers may with good reason be reduced.

The species belonging to the Scandinavian fauna may be distributed between two genera, *Cyclogaster*, with one, continuous, dorsal fin, and *Cyclopterus*, with two dorsal fins, the anterior, however, being gradually covered during growth by the skin.

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[a] *Règne Animal*, nouv. éd., tome II, p. 344; *Discoboli*, MÜLL., Abh. Akad. Wiss. Berlin, 1844, Physik. Abh., p. 156.

[b] See *Isis*, 1833, p. 1201.

[c] *Lepadogaster*, a member of the following family, was referred by RISSO to the family *Gobioides* (*Eur. Mér.*, tome III, p. 271).

[d] *Brit. Mus. Cat. Fish.*, vol. III, p. 154, *Discoboli*.

GENUS CYCLOGASTER.

Body tadpole-like, more or less pointed towards the caudal fin, and covered with a slimy and loose skin, which is naked or (in old specimens) sometimes rough with scattered, small plates, and thickly, but loosely, covers the anterior part and the base of the long, continuous, dorsal fin, and also of the anal fin. Pseudobranchiæ wanting or rudimentary. Vertebræ more than 40.

Obs. RONDELET[a] borrowed from PLINY the name of *Liparis*[b] for a fish which probably did not belong to this genus, and WILLUGHBY was the first clearly to describe a species belonging to this genus under that name, with the addition of the English name of Sea-snail, which is still in use. Neither ARTEDI[d] nor LINNÆUS[e] knew this fish from his own observations; and as LINNÆUS did not recognise *Liparis* as a distinct genus, and ARTEDI gave no diagnosis thereof, this genus, according to the laws of nomenclature, must now bear the name of *Cyclogaster*, which it received of GRONOVIUS[f], who was the first author to give a scientific description and determination of the genus. He states that in Belgium it is called *Ringbuyk*. In Sweden, according to KOLTHOFF[g], it is called *Sugfisk* (Sucking-fish); but neither EKSTRÖM nor MALM give any name used by the fishermen of Bohuslän. NILSSON employed the name of *Lumpfisk*, MALM that of *Sugare* (Sucker). KRØYER translated *Cyclogaster*, and called the genus *Ringbug*.

The slimy and, in most cases, entirely naked skin is only loosely attached to the body by a subjacent layer of loose, connective tissue; and the variability thus caused in the external shape of the body, as well as the consequent difficulty of preserving the fish in a perfect state, and lastly the large number of colour-varieties which we find among the young specimens, have rendered the determination of the species within this genus no easy task. However, if we compare all the species described, we easily find that they compose a distinct, continuous series of forms, starting from those which approach nearest to the juvenile stages of the following genus, and acquiring a greater and greater number of rays in the dorsal and anal fins, until these fins imperceptibly coalesce with the caudal fin, while the body simultaneously becomes more and more elongated and pointed towards the tail. The adhesive ventral disk also moves farther and farther forward, and is reduced in size, suggesting a continuation of this change, and finally disappears[h], the family thus gaining a deceptive likeness to certain forms of the *Cottidæ* and *Ophidiidæ*. As this series of forms is represented in the changes of growth of individual forms, we also regard it as the expression of a true developmental series, even though it be of a retrograde character. The different stages of this development may, in different localities or at different ages, show a greater or less degree of constancy; but transitions involve an inconstancy of character. GÜNTHER'S opinion of the only known specimen of *Paraliparis membranaceus* may thus apply to still more of the species described: "It is uncertain whether this specimen represents a species in which certain embryonic characters are persistent, or merely an early stage of development of some other species". In the Scandinavian fauna we follow the example of COLLETT, LILLJEBORG and LÜTKEN, and distinguish between the three following species only:

A: Rays of the dorsal fin more than 50, of the anal fin more than 40. Vent situated in the first quarter of the length of the body. Length of the adhesive disk equal to or slightly greater than the diameter of the eye .... *Cyclogaster gelatinosus*.

B: Rays of the dorsal fin less than 50, of the anal fin less than 40. Vent situated behind the first quarter of the length of the body. Length of the adhesive disk twice the diameter of the eye:

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[a] *De Pisc.*, lib. IX, cap. VIII.

[b] From *λιπαρός*, *sleek*. Descriptio ad eum dignoscendum non multum valet: RAY.

[c] *Hist. Pisc.*, App., p. 17.

[d] *Synon.*, p. 117.

[e] *Syst. Nat.*, ed. XII, tom. I, p. 414, *Cyclopterus liparis*.

[f] *Mus. Ichth.*, tom. II, p. 9; *Zoophyl.*, fasc. I, p. 55; *Cat. Fish. Gron.*, Brit. Mus., ed. GRAY, p. 39.

[g] In LILLJEBORG, l. c.

[h] In the genus *Paraliparis*, a deep-sea form, found at a depth of from 300 to 600 fathoms in the Atlantic, from Bear Island down to Cape Vincent. See COLLETT, Norsk. Nordh. Exped. 1876—78, Zool., Fiske, p. 53 (*Paraliparis bathybii*); BROWN-GOODE, Proc. U. S. Nat. Mus. 1880, p. 477 (*Amitra liparina*); JORDAN and GILBERT, *Syn. Fish. N. Amer.*, Bull. U. S. Nat. Mus., No. 16, p. 739; GTHR., Voy. Chall., vol. XXII, *Rep. Deep Sea Fish.*, p. 68.

a: Base of the anal fin at least 10 times the least depth of the tail (at least in adult specimens). Rays of the dorsal fin at least 32, of the anal fin at least 26 *Cyclogaster liparis.*

b: Base of the anal fin less than 9 times the least depth of the tail (even in adult specimens). Rays of the dorsal fin at most 32, of the anal fin at most 25.......... *Cyclogaster Montagui.*

MONTAGU'S SEA-SNAIL.

CYCLOGASTER MONTAGUI.

Plate XV, figs. 2—6.

Rays of the dorsal fin 26—32, of the anal fin 22—25. Least depth of the tail more than 11 % of the length of the base of the anal fin. Length of the caudal fin more than 70 % of that of the head. Distance between the anal fin and the vent less than $^1/_3$ of the distance between the former and the tip of the snout, and the distance between the vent and the tip of the snout more than $^1/_4$ of the length of the body. In adult specimens only one pair of nostrils, the posterior pair being covered by the skin.

R. br. 6; *D.* 26—32; *A.* 22—25; *P.* 27—30; *V.* 6; *C.* $x+10+x$; *Vert.* 35 l. 36.

Syn. *Gobius*, Müll., Rtke, *Zool. Dan.*, fasc. IV, p. 16 et 38, tab. CXXXIV et CLIV.

Cyclopterus Montagui, Donov., *Brit. Fish.*, vol. III, tab. 68; Mont., Mem. Wern. Soc., vol. I, p. 91, tab. V, fig. 1; Cuv. (*Liparis*, subg.), *Règn. Anim.*, ed. 2, tom. II, p. 346; Yarr. (*Liparis*), *Brit. Fish.*, ed. 2, vol. II, p. 374; Krøy., *Danm. Fiske*, vol. II, p. 519; *Voy. Scand. cett.* (Gaim.), tab. 13, fig. 1; Naturh. Tidskr. Kbhvn, ser. III, vol. 1, p. 243; Nilss., *Skand. Fn., Fisk.*, p. 239; Gthr, *Cat. Brit. Mus., Fish.*, vol. III, p. 161; Malm, Förh. Skand. Naturf. Möte, Sthlm 1865, p. 411; *Gbgs, Boh. Fn.*, p. 451, tab. VII, fig. 1; Malmgr., Öfvers. Vet.-Akad. Förh. 1867, p. 262; Coll., Forh. Vid. Selsk. Christ. 1874, Tillægsh., p. 63; ibid. 1879, No. 1, p. 37; N. Mag. Naturv. Christ., Bd. 29 (1884), p. 64; Winth., Naturh. Tidskr. Kbhvn, ser. 3, vol. XII, p. 20; Hansson, Öfvers. Vet.-Akad. Förh. 1880, No. 4, p. 21; Day, *Fish. Gt. Brit., Irel.*, vol. I, p. 186, tab. LVI, fig. 2; Jord., Gilb., Bull. U. S. Nat. Mus., No. 16, p. 743; Möb., Hcke, *Fische d. Osts.*, p. 56; Lillj., *Sv., Norg. Fisk.*, vol. I, p. 703; Hansen, *Zool. Dan., Fiske*, p. 40, tab. VII, fig. 1; Ltkn, Dijmphna-Togt. zool. bot. Udb., p. 139, cett.

Cyclopterus (Liparis) liparoides + Cycl. (Lip.) gobius, Nilss., *Prodr. Ichth. Scand.*, p. 62; *Lip. gobius*, Schagerstr., Vet.-Akad. Handl. 1838, p. 248.

Liparis lineatus + Lip. maculatus + Lip. Ekströmii, Malm, Förh. Skand. Naturf. Möte, Sthlm 1865, p. 412; *Lip. vulgaris + L. maculatus + L. Ekströmii*, Id., *Gbgs, Boh. Fn.*, p. 447, tab. VII, fig. 2; p. 461, tab. VII, fig. 3; p. 464, tab. VII, fig. 4; *Lip. Ekströmii*, Ltkn, Vid. Meddel. Naturh. For. Kbhvn 1865, p. 221; *Lip. vulgaris + L. Ekströmii*, Hansen, *Zool. Dan. Fiske*, p. 41, tab. VII, figg. 2 et 3.

The well-known shape of the tadpole is the most suitable expression of the shape of the body in this species, as well as in the two following ones. To the posterior extremity of the abdominal cavity the anterior part of the body is terete or, in the front part of the head, even depressed; behind this point the tail is laterally compressed. The most remarkable departure in Montagu's Sea-Snail from the tadpole form lies, however, in the lack of continuity in the vertical fins, the dorsal fin being generally entirely separate from the caudal, and the anal fin, though it may sometimes advance for some distance along the lower margin of the caudal fin, being always distinct from the latter. In the gravid female the greatest depth of the body may be as much as $^1/_4$ of the length, and in the male as little as $^1/_5$. The difference chiefly lies, as usual, in the degree of distension of the belly. The greatest breadth (thickness) is always somewhat, sometimes considerably, less than the greatest depth, and in the male may sink to about 15 % of the length of the body. The difference between the breadth of the head and that of the belly is always slight; but the latter is sharpened above, towards the dorsal edge; and though in young specimens it passes fairly evenly at the end of the abdominal cavity into the compressed caudal part, in older specimens, especially in gravid females, the division between the belly and the tail is sharply marked. The superior and inferior profiles of the tail converge evenly towards the base of the caudal fin, where the least depth of the tail varies between about 5 and 7 % (from 4·8 to 6·9) of the length of the body. In the female, according to Day, the latter may be as much as 5 in. (125 mm.); but we have no further information of specimens of this size. The largest specimen of this species which the Royal Museum possesses, was received from Finmark through Mr. F. Bull of Hammerfest, and is 101 mm. long. The longest Swedish specimen is a female 76 mm. in length, which was taken by Mr. C. A. Hansson off Strömstad at a depth of no more than a foot or so.

In adult specimens in general the length of the head is equal to the greatest depth of the body, or less than the latter, sometimes sinking as low as 19 % of the length of the body. In the fry it is, as usual, relatively greater[a]. The eyes are small, their longitudinal diameter, in adult specimens from 40 to 80 mm. long, varying between 16 and 14 % of the length of the head, or between 55 and 44 % of the breadth of the slightly convex interorbital space, or between 55 and 75 % of the least depth of the tail. The blunt and in most cases, convex snout, the length of which is rather more than $^{1}/_{3}$ of that of the head, is furnished superiorly, in front of the eyes and somewhat nearer the middle of the head, with two tubular nostrils; and behind the latter, just within the upper anterior corner of the eye, there sometimes appears in young specimens a small hole or transverse slit on each side, forming the posterior nostril, but in most cases closed, covered by the skin, and visible only as a small dermal protuberance. The mouth, which lies at the very tip of the snout, with the upper jaw projecting only slightly beyond the lower, is small, but fairly broad, the breadth of the gape, which is horizontal, measuring about half the length of the head. The dental card on the intermaxillary bones, as well as that in the lower jaw, is broad (containing many rows) in the middle, the teeth being tricuspid, with the middle point longest. The lips, both the upper and the lower, are each furnished with a row of pores along the margin, generally containing 4 pores on each side, and from the upper lip there also runs, in the direction of the nasal region, a row of two similar pores on each side. The further extension of the system of the lateral line on the head is externally visible in the pores round the eyes, and in a row which is the only external indication of the margin of the preoperculum; but of the lateral line proper we find only two pores on each side, just above the upper corner of the gill-opening. The latter is a perpendicular slit, the lower third or fourth of which lies just in front of the upper part of the base of the pectoral fin. The length of this slit, however, varies considerably, between $^{1}/_{2}$ and $^{1}/_{4}$ of the length of the head. The anterior margin of the slit, or the opercular margin, projects at about the middle into a more or less obtuse dermal flap, which fits into the upper angle of the pectoral fin, and the thin frame of which is formed by the end of the elongated, triangular, forked or almost crescent-shaped operculum, together with the hind part of the subjacent, narrow and bent suboperculum, which is of almost uniform breadth. The rest of the branchiostegal membrane is united to the skin of the body, but forms a fold which hangs like a collar across the throat and the isthmus. This membrane is often so thin that one can easily count the six branchiostegal rays on each side of the body, together with the interoperculum, which is of exactly the same shape, and extends from the articulation of the lower jaw in a curve parallel to the lower posterior margin of the preoperculum. The interoperculum has often been reckoned by mistake among the branchiostegal rays.

The pectoral fins are very broad at the base, which inferiorly curves forward, in a direction parallel to the fold of the branchiostegal membrane and in front of the ventral disk, the pectoral fin on the one side being separated from that on the other by a distance no greater than the diameter of the eye. All the rays of these fins are simple and furnished with a fairly thick skin, the lower ones being free at the tip. The lowest rays are very short and only gradually increase in length; but above the longest of them are a few slightly shorter rays, the lowest part of each pectoral fin, with the tips of the rays turned outwards, thus resembling a distinct division or lobe of the fin. The upper part of the fin is obtusely rounded, the superior rays being of fairly uniform length. The length of the fin from the upper angle of the insertion is about 15—17$^{1}/_{2}$ % of the length of the body, and from the front part of the lower end of the base about 24$^{1}/_{2}$—26 % thereof. When folded the pectoral fins extend to the perpendicular drawn just behind the vent, or even half-way between the latter and the beginning of the anal fin. The longitudinal diameter of the round or somewhat oblong sucking-disk formed by the ventral fins, together with its marginal fold, is about 11 or 11$^{1}/_{2}$ % of the length of the body and $^{1}/_{2}$ the length of the head or more. When the fish is in its normal state, this diameter is only slightly less or even equal to the distance between the disk and the tip of the snout; but when the dorsal muscles are contracted and the opercula expanded, as often happens when the fish is thrown into strong spirit, this relation undergoes considerable alteration, the disk, the anterior margin of which is generally situated almost vertically below the hind margin of the eye, now lying almost entirely behind the head. The vent, which is situated about half-way between the hind margin of the base of the sucking-disk and the beginning of the anal fin, is large and broad, especially in the female, as its dermal fold also encloses the transverse genital opening, behind the vent proper. The margin of the genital opening is often verrucose, and the genital papilla is distinct in the males, less so in the females. The dorsal fin occupies the greater part of the back, but varies somewhat in this respect, the distance between it and the tip of the snout being from 22 to 29 % of the length of the body. The distance between its last ray and the caudal fin is equal to, or somewhat less than, the least depth of the tail, but this space is generally filled by the fin-membrane, and the tips of the last two rays of the dorsal fin, when depressed, sometimes extend to the base of the caudal fin. The first rays of the dorsal fin, generally to a number of 13, are true, unarticulated, spinous rays, and behind this point the rays are simple, but articulated. The margin of the fin forms a double curve in the following fashion: the middle spinous rays are shorter than the rays on either side of them[a], while the rays immediately following them are gradually elongated as they pass into the soft rays, but the middle soft rays are the longest in the whole fin. The caudal fin is truncate, but rounded at the corners. Its length varies between $16^1/_2$ and 19 % of that of the body, or between 72 and 95 % of that of the head. The anal fin is analogous to the posterior part of the dorsal fin in form and structure, but lies a little further back, the tips of its hindmost rays, when depressed, generally extending to the base of the caudal fin and sometimes a little beyond it. The first 3 or 4 rays are spinous. The anal fin is longer in the male than in the female; and if its length be measured to the base of the caudal fin, the dividing-line between the characters of the two sexes, in an adult state, falls at about 45 % of the length of the body. One of the results of this circumstance is that the distance between the anal fin and the tip of the snout is greater in the female than in the male, and in this case the dividing-line seems to lie at about 43 % of the length of the body.

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[a] In a male 71 mm. long, from Bohuslän, the length of the head is only 13$^{1}/_{2}$ mm.; in a young specimen 18 mm. long, from the same locality, the length of the head is 27·8 % of that of the body.

In adult specimens (Plate XV, fig. 2) the colour is generally brownish red, above and in front darker, below and behind lighter, and everywhere strewn with small, dark spots and dots, which on the fins form bands straight across the rays. Lighter varieties also occur, however, in which the ground-colour shades more or less distinctly into yellow, green or gray. Even v. Wright gives a figure of a fairly large young specimen (Plate XV, figs. 3 and 4), which was pale yellow, with pale red spots; and Malm's *Liparis maculatus* is a colour-variety of the same description, though more strongly tinged with gray. Another form, most common among young specimens, but sometimes occurring among older ones, is marked with dark lines on the lighter ground-colour, which are undulating, melting into elliptical rings, or interrupted (Plate XV, fig. 5). For this variety we have obtained permission to borrow Malm's figure of his *Liparis vulgaris*. Light spots on a dark ground-colour, on the other hand (Plate XV, fig. 6), mark the variety described by Malm, and entitled *Liparis Ekströmii*. In this variety, when the spots become predominant, and the ground-colour appears only as a network, we have Couch's[b] *Liparis reticulatus*. With regard to all these colour-varieties and their intermediate forms, of which Collett gives eight, we may refer the reader to Heincke's remarks on the variations of colour in the Gobies, as quoted above (p. 252).

Montagu's Sea-Snail or, the Lesser Sea-Snail, as it has also been called, not without reason, is described by Day as a comparatively lively fish, but is by no means destitute of the power or the habit, which it shares with the other members of the family, of attaching itself to some object by means of its sucking-disk. At such moments these fishes lie in a coil, with the tail curved towards the head, in the position shown in our figure (Plate XV, fig. 4). This species is often found in this position, hidden among the stones at the ebb, either above low-water mark or in very shallow water. It is also found, however, in the deepest sea-weed-regions, at as great a depth as 20 fathoms at least. Its habits are, with this exception, little known. From March to July, on the coast of Bohuslän, gravid females occur near shore, having probably come there to spawn. The food of this species is composed of Gammarids and other small crustaceans, and small shellfish. It is of no importance to the fisherman. Its geographical range extends from Norwegian Finmark to the southern coasts of England and Ireland[a]. On the west coast of Sweden it goes as far as the Sound, where it was first discovered off Landskrona by SCHAGERSTRÖM. On the Danish side it has also been found fairly often off Hellebæk. In the Great Belt, according to WINTHER, two specimens about 100 mm. long have been taken in Eel-pots. It has also been found off Möen and in the Little Belt; but in the Baltic itself it is unknown. Whether it occurs on the coast of Greenland, seems according to the results of LÜTKEN's investigations[b], to be a matter of doubt; but according to JORDAN and GILBERT it occurs on the American side of the Atlantic, on the coast of Massachusetts.

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[a] In a Californian form, *Cyclogaster* (*Neoliparis*) *mucosus*, this bend is so deep that the dorsal fin is apparently divided into two parts (Steindachner, *Ichth. Beitr.* (III), p. 54).

[b] *Fish Brit. Isl.*, vol. II, p. 195, tab. CVII, fig. 3.

THE COMMON SEA-SNAIL.

CYCLOGASTER LIPARIS.

Plate XV, figs. 7—10.

Rays of the dorsal fin 32—45[c], of the anal fin 26—38. Least depth of the tail less than 10 % of the length of the base of the anal fin. Length of the caudal fin less than 66 % of that of the head. Distance between the anal fin and the vent less than $^{1}/_{3}$ of that between the former and the tip of the snout, and the distance between the vent and the tip of the snout more than $^{1}/_{4}$ of the length of the body. Two pairs of nostrils.

R. br. 6; *D.* 32—45[c]; *A.* 26—38; *P.* 32—42; *V.* 6; *C.* $x + 10 + x$; *Vert.* 46—50[d].

Syn. *a:* forma microps.

Liparis nostras, WILLUGHBY, *Hist. Pisc.*, *App.*, p. 17, tab. *H.* 6, No. 1.

Cyclopterus Liparis, LIN., *Syst. Nat.*, ed. XII, tom. I, p. 414; FABR., *Fn. Groenl.*, p. 135; BL., *Ausl. Fische*, Th. 1, p. 48, tab. CXXIII, fig. 3 et 4.

Cyclopterus lineatus, LEP., N. Comm. Acad. Petrop., tom. XVIII, p. 522, tab. V, figg. 2 et 3; KR. (*Liparis*), *Voy. Scand.*, *Lapon.*, cett (GAIM.), tab. 13, fig. 2; Naturh. Tidskr. Kbhvn, ser. II, vol. II, p. 284; ibid., ser. III, vol. I, p. 244; LTKN, Vid. Meddel. Naturh. For. Kbhvn 1860, p. 174; ibid. 1861, p. 243, tab. VII, fig. 1; MGRN, Öfvers. Vet.-Akad. Förh. 1867, p. 262; COLL., Vid. Selsk. Forh. Christ. 1874, Tillægsh., p. 65; ibid. 1879, No. 1, p. 41; ID., Norsk. Nordh. Exped. 1876—78, Zool., Fiske, p. 50; ID., N. Mag. Naturv. Christ., Bd. 29, p. 65; MELA, *Vert. Fenn.*, p. 285, tab. IX; JORD., GILB., Bull. U. S. Nat. Mus., No. 16, p. 742; LILLJ., *Sv.*, *Norg. Fisk.*, vol. I, p. 688.

Liparis vulgaris, FLMNG, *Brit. Anim.*, p. 190; GTHR, *Cat. Brit. Mus. Fish.*, vol. III, p. 159; WTHR, Naturh. Tidskr. Kbhvn, ser. III, vol. XII, p. 20; DAY, *Fish. Gt. Brit.*, *Irel.*, vol. I, p. 184, tab. LVI, fig. 1; MÖB., HCKE, *Fische d. Osts.*, p. 57.

Liparis barbatus, EKSTR., Vet.-Akad. Handl. 1832, p. 169, tab. V; KR., *Danm. Fiske*, vol. II, p. 534; NILSS., *Skand. Fn.*, *Fisk.*, p. 237; LOVÉN, Öfvers. Vet.-Akad. Förh. 1862, p. 465; Förh. Skand. Naturf. M. Sthlm 1863, p. 62; MGRN, *Finl. Fisk.* (disp.) Helsingfors 1863, p. 18; Öfvers. Vet.-Akad. Förh. 1864, p. 510; LINDSTR., Gotl. Läns Hush. Sällsk. Årsber. 1866, p. 16 (sep.); ESM., Forh. Skand. Naturf. M. Christ. 1868, p. 525.

Liparis tunicatus, REINH., Danske Vid. Selsk. Naturv., Math. Afh., Deel 6 (1837) Overs., p. CXI; KR., Naturh. Tidskr. Kbhvn, ser. III, vol. 1, p. 236; LTKN, *Dijmpha-Togtets zool. bot. Udb.*, p. 151.

Liparis Fabricii, GTHR, l. c., p. 161; *Liparis lineata + arctica + Fabricii + major*, GILL, Proc. Acad. Nat. Sc. Philad. 1864, p. 191; *Liparis gibbus*, BEAN, Proc. U. S. Nat. Mus., vol. IV, p. 148.

Liparis gelatinosus, PETERS, Die Zw. Deutsche Nordpolarfahrt (1869/70), vol. 2, p. 171, tab. 1, fig. 2.

b: forma megalops.

Liparis Fabricii, KR., *Voy. Scand.*, *Lapon.* cett. (GAIM.), tab. 8, fig. 2; Naturh. Tidskr. Kbhvn, ser. II, vol. II, p. 274; ser. III, vol. I, p. 235; MGRN, Öfvers. Vet.-Akad. Förh. 1864, p. 513; LTKN, Dijmphna Togt., l. c., p. 146, tab. XV, figg. 4 et 5.

? *Liparis ranula*, GOODE et BEAN, Proc. U. S. Nat. Mus., vol. 2 (1879), p. 46.

Liparis lineatus, var. Fabricii, SM., *Gt. Intern. Fish. Exhib. London 1883, Swed. Cat.*, p. 176.

Obs. In their extremes the two varieties of this species, as shown, for example, in the figures of both in KROYER and LÜTKEN which are above referred to, are sharply and easily distinguished by the larger eyes, the more tumid snout, the longer pectoral fins, the more anterior position (in most cases) of the ventral disk, and the black peritoneum of *Cyclogaster Fabricii*. But the transitions deprive these characters of their value, and the dubiousness of these varieties is forced upon us, especially when we have to decide to which of them the Baltic form should be referred. We have already[a] declared our opinion, when arranging the collection of fishes made by the Vega Expedition in the Arctic Ocean off Siberia, that *Cyclogaster Fabricii* is a variety of the Common Sea-Snail, and a new examination of all the examples of this species belonging to the Royal Museum has still further strengthened this impression.

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[a] As MOREAU (*Hist. Nat. Poiss. Fr.*, vol. III, p. 353) states the number of the vertebræ in his *Liparis vulgaris*, at 32 or 33, it seems probable that *Cyclogaster Montagui* also occurs on the north part of the west coast of France.

[b] Dijmphna Togtet, l. c., p. 143.

[c] Sometimes 49, according to LÜTKEN.

[d] 42, according to GÜNTHER; sometimes 53, according to LÜTKEN. MALMGREN found 45 and 46 in specimens from Spitzbergen.

The Common Sea-Snail attains a considerably greater size than the preceding species, but only in its true home, the Arctic Ocean, where it may be at least 275 mm. long. In Sweden, however, it scarcely ever exceeds half this size. The form of the body is essentially the same as that of the preceding species; but the caudal part is still more compressed, and its outlines converge more sharply towards the caudal fin, the least depth of the tail varying between 3 and $4^1/_2$ % (3·1—4·2 %) of the length of the body. The head is generally larger in this species than in the preceding one, its length in most cases being about $^1/_4$ (from 24 to 27 %) of that of the body[b]. The eyes are also larger, but vary considerably in respect of size. They are, as usual, relatively larger in young specimens than in old — in a specimen 19 mm. long, from the Baltic, the longitudinal diameter of the eye is 8·4 % of the length of the body and 31·3 % of the length of the head, in middle-sized specimens (under 100 mm. in length) the usual size of the eyes is 4 or 5 % of the former and from 15 to 20 % of the latter, while in the largest specimens (170 mm. or more in length) it may sink to $2^1/_2$ % of the length of the body and 10 % of the length of the head. We also find, however, that in the variety which has received the name of *Cyclogaster Fabricii*, the large eyes are generally persistent, their longitudinal diameter varying between 6 and 8 % of the length of the body and 18 and 28 % of the length of the head. The breadth of the interorbital space also varies considerably, between about 7 and 14 % of the length of the body, but is generally greater than in the preceding species. The anterior pair of nostrils are rather high and tubular, the posterior generally appear merely as transverse slits on each side, at the side of the anterior upper corner of the eye, but the margin of these slits is also considerably raised in some instances. Among the jaw-teeth, which with this exception resemble those of the preceding species, LÜTKEN found, in old specimens, some simple (single-pointed) teeth, like those which STEINDACHNER (l. c.) has described in the Californian species *Cyclogaster* (*Liparis*) *pulchellus* and *Cyclog.* (*Neoliparis*) *mucosus*. The character which has been derived from this peculiarity, and employed as a generic distinction between this species and the following one, thus loses its validity. The nature of the skin and the extension of the system of the lateral line, on the head and the body, are the same as in the preceding species. Of the lateral line on the body there generally appear, in this species too, only the first two pores (ducts); but LÜTKEN has described perfect lateral lines, though with some distance between the pores, in *Cyclogaster Fabricii*, and the lateral line is also complete in the largest specimens of the common form from Spitzbergen. The small, round, granular plates on the skin are more common, especially on the head and the front part of the back, in this species than in the preceding one.

The pectoral fins are generally longer than in Montagu's Sea-snail, especially in the Baltic form and *Cyclogaster Fabricii*, where their length from the upper angle of the insertion to the tip of the longest rays may rise to 20—25 % of that of the body. In young specimens, however, in this species also, their length is no more than 15 % of that of the body. The dorsal and anal fin are distinguished from those of the preceding species — apart from the greater number of the rays, which has already been remarked — partly by the fact that the descending curve in the margin of the former is much less marked, sometimes quite imperceptible, in this species, and that the longest rays of these fins are situated somewhat farther forward, and partly by the fact that both these fins are continued much further out on the caudal fin, and in Arctic specimens which are normal in other respects, are sometimes so closely united to the latter, that the line of demarcation between them is externally invisible. We find an example of this in *Cyclogaster lineatus* as first described by LEPECHIN; and the species thus departs considerably from the form common in more southern localities, which in this respect sometimes comes very near Montagu's Sea-Snail — so near that this character can scarcely be regarded as a valid one — and approaches the fully tadpole-like form of the tail which belongs to the specimens just mentioned, which are far from the commonest, even in Spitzbergen. The peculiarity of the caudal fin, on the other hand, in this species is its smaller length, which varies between 11 and 14 % (occasionally rising, however, to $16^{1}/_{2}$ %) of the length of the body, or between 40 and 65 % of that of the head. The adhesive disk formed by the ventral fins is also less than in the preceding species, its length never rising to $^{1}/_{2}$ that of the head, and sometimes sinking as low as to 36 % thereof. It is sometimes surrounded even in front by the pectoral fins, a dermal flap uniting the latter to each other — this is distinctly the case, for example, in a specimen from Bravik (a firth of the Baltic Sea), and also in one of Lütken's figures of *Cyclogaster Fabricii* from Kara Sea — but in this species as in the preceding one, there is generally an interval between the pectoral fins. The position of the vent varies considerably: in a young specimen 28 mm. long, from Stor Fjord (Spitzbergen), which, however, still retains distinct traces of the larval stage, the vent lies close to the beginning of the anal fin; in a specimen 53 mm. long, from the same locality, the distance between the vent and the anal fin is $^{1}/_{3}$ of that between the latter and the ventral disk; and in a specimen 60 mm. long, from the neighbourhood of Visby (Gothland), the former distance is $^{2}/_{3}$ of the latter. In ordinary cases, however, the vent lies about half-way between the ventral disk and the anal fin.

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[a] Fish. Exhib., London 1883.

[b] Only exceptionally have we found the length of the head so small as 22 % of that of the body; and these exceptions may well be due to the difficulty of taking sure measurements from the loose tip of the snout.

The coloration is essentially the same as in the preceding species, and is no less variable. In full-grown specimens, however, at least in Sweden, it is usually darker, the ground-colour being more distinctly tinged with gray; and the brown dots are more often collected into transverse bands on the fins and the body. These bands are in most cases very irregular, as is shown in v. Wright's two figures of Scandinavian specimens (Plate XV, figs. 7 and 9), and in a colour-variety common in the Arctic regions, the transverse bands are interrupted at the middle of the sides and their superior and inferior parts are set alternately opposite the spaces between them, a dark band from the back lying vertically above a lighter band from the anal side and *vice versâ.* The belly itself, on the other hand, is usually of a uniform gray or red, dotted with brown. In *Cyclogaster Fabricii* the black peritoneum generally shines through. Lepechin's specific name (*lineatus*) is derived from a variation of colour common in this species too, where the markings of the body are arranged in longitudinal, undulating streaks. In short, we may find every conceivable variation and transition between unicoloured, dotted, spotted and streaked forms, light or dark, reddish or grayish, yellow or even blue varieties. Collett, indeed, gives ten of these different forms. As in the preceding species, however, these variations of colour belong chiefly to the younger specimens. The variety remarked by Malm (*stellatus*), with star-shaped chromatophores in the skin, is also marked (Plate XV, fig. 10) by a St. Andrew's cross of sepia-coloured streaks from the eye. This marking is partly represented in one of v. Wright's two figures, and may also occur, according to Hansson, in the preceding species.

The Common Sea-Snail is of especial interest in the geology of Scandinavia and Finland during the period immediately preceding that known by geologists as the Recent or Human. Its occurrence in the Baltic is one of the relics collected by S. Lovén, of the quaternary, northern connexion between this sea and the Arctic Ocean. The species has received greatest prominence from Ekström's description of it, under the name of *Liparis barbatus*[a], as occurring in the island-belt of Mörkö, where he found specimens 130 mm. long. Far up in the Gulf of Bothnia, too, this species attains a length of at least 90 mm., for one of the specimens in the Royal Museum[b], which was taken by Mr. Åbom off Neder-Kalix, is 94 mm. long. According to Mela it occurs both in the island-belt of Åbo and off the island of Hogland in the Gulf of Finland. Lindström assigns it to Gothland, and has presented to the Royal Museum a male 60 mm. long, from the neighbourhood of Visby. In the south of the Baltic, however, it was unknown until Théel and Trybom during the voyage of the gunbout *Gunhild*, in July, 1878, took a small specimen 19 mm. long, south of Ystad, and some other small specimens, the largest of which was 26 mm. long, between Möen and Arcona. All these last specimens were found at a depth of 10 or 11 fathoms, among stones and sea-weed on a sandy bottom. Off Kiel it does not occur, according to Möbius and Heincke; and on the east of Denmark it is very rare, though found off Hellebæk (the Sound), and the specimens taken are very small: the largest on record was caught in the Great Belt at a depth of 10 fathoms, and was only 50 mm. long (Winther and Hansen). In Bohuslän it can scarcely be called rare; but even there only small specimens are common: among all his finds Malm mentions only two large specimens, between 72 and 75 mm. long, both from the island-belt of Gothenburg. In Norway it is somewhat commoner, but more so in the north than in the south, according to Collett. In the Orkneys it is common, according to Day, who gives statements to a similar effect from several places in Scotland, England and Ireland, but also points out the uncertainty whether all these statements refer to this species or the preceding one. As we have remarked above, the same uncertainty rules in Moreau's statement as to the rare occurrence of the species on the north-west coast of France in the Channel. That the range of this species extends further south than the Baltic, is thus unquestionable; but even from the fact that, in the south, it is so often confounded with the preceding species[a], we surmise that there it does not appear in its typical form[b], or does not follow its normal manner of life. It is far more typical in the Baltic, though, strangely enough, only in the inner parts of this sea, while in the south and west of the Baltic and in the east of the Cattegat we find a distinct departure from the typical form. Professor S. Lovén ascribes this peculiarity to the same origin as the occurrence of several other Arctic animals in the Baltic (see above, on *Cottus quadricornis*), and thus defends his conception of the history of the Baltic at the time when it was a gulf of the Arctic Ocean. *Cyclogaster liparis* must be regarded, in the first place, as an Arctic species, for it attains its highest point of development in the Arctic Ocean, and is of more common occurrence there than in any other part of its geographical extension. Since Phipps' expedition in 1773 it has been included in the fauna of Spitzbergen. The Swedish expeditions to these islands have also discovered it at most of the spots examined, from high-water mark to a depth of from 20 to 25 fathoms, and on every variety of bottom. *Cyclogaster Fabricii* seems there to be less common, but all the more so in the east of the Arctic Ocean. During the Vega Expedition numerous examples of this species, from 90 to 130 mm. in length, were taken in shallow water (3—6 fathoms deep), off Irkajpij (69° N., 180° E.), and another specimen, punctated like a *stellatus*, at a depth of 35 fathoms, north-east of Taimyr Peninsula (76° 40′ N., 115° 30′ E.). During the Dijmphna Expedition, according to Lütken, about 50 specimens were found at depths varying between 46 and 106 fathoms, in Kara Sea. Another instance of the occurrence of the species in deep water, which probably refers to the common variety, is given by Günther[c], namely, the discovery of a specimen by the Porcupine expedition at a depth of 180 fathoms, north of the Shetlands. It may also be met with, on the other hand, at the surface. In Varanger Fjord, in July, 1879, Professor G. O. Sars is stated on Collett's authority to have found the fry swimming about among those small pelagic crustaceans which are called by the fishermen *Sej-aat* (Coalfish-meat), as they form part of the food of the Coalfish. The species is circumpolar, and is included among the fauna of Greenland even by Fabricius. On the west of the Atlantic, according to the American writers, it goes as far south as Cape Cod. How far south its range extends in the Pacific, is a question which cannot be decided until the relations between the Atlantic forms and the two Californian varieties[d] have been fixed.

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[a] This specific name is derived from the beard-like lower lobe of the pectoral fins, and as early as 1785 Bloch had given the species the name of *Der Bartfisch, Cyclopterus pinna pectorali barbiformi.*

[b] A female with almost ripe roe, taken at the end of April (1842).

The habits of the Common Sea-Snail probably correspond to those of the preceding species. Of the specimen which he kept alive for some time, EKSTRÖM writes: "When the fish left off swimming about in the vessel in which it was kept, it attached itself to the bottom, and drew the compressed part of the body tightly up to the left side, thus acquiring, when still, an almost spherical form." This specimen was a female 130 mm. long, which at the beginning of May contained running roe, "of a light carmine colour," the eggs being slightly more than 1 millimetre in diameter. In April, 1849, in Bravik, Mr. G. VON YHLEN took another female, in which the development of the eggs was equally far advanced. These instances give us an approximate indication of the spawning-season in more northern localities, when we remember that SARS, as we have mentioned above, found young specimens up to 15 mm. in length, swimming at the surface in Varanger Fjord, during the month of July.

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[a] According to his opinion in 1860 (Vid. Meddel., pp. 169—174) and 1865 (ibid. 1865, p. 221), Lütken included this species (*Liparis lineatus*) among the fishes of Denmark. But in 1886 (*Dijmphna-Togtet*, l. c.) he regards only the preceding species (*Liparis Montagui*) as really belonging to the Danish fauna, and asserts that Malm's *Lip. stellatus*, as proved by the personal statements of the latter, belongs to the preceding species. In the fauna of Great Britain Day distinguishes between *Lip. vulgaris* and *Lip. Montagui* by the number of the fin-rays and the length of the caudal fin, but remarks of both that the dorsal fin is hardly united to the caudal, while it appears from his description of the nostrils that he has overlooked the true posterior pair in both cases.

[b] Or, more correctly perhaps, that we shall eventually be driven to the conclusion that in the south the two species are indistinguishable, i. e. that *Cyclogaster Montagui* should be regarded as a variety, essentially southern, of *Cyclogaster liparis*.

[c] *Voy. Challenger, Rep., Zool., Deep- Sea- Fishes*, p. 67.

[d] According to Steindachner (l. c.) the Californian species *Liparis pulchellus* and *Lip. mucosus* established by Ayres, are distinct from the two Scandinavian species of *Cyclogaster*. But the difference between the first two species, in form and colour, is evidently parallel to that between *Cycl. liparis* and *Cycl. Montagui*, and so similar that it may well excite our suspicions that the species are identical.

COLLETT found the food of the Common Sea-Snail to consist of small crustaceans and worms; LILLJEBORG also found small shell-fish (*Rissoa*) in its stomach. According to FABRICIUS the fry of other fishes and sea-weed also form a part of its diet. It is of no greater economical importance to man than the preceding species, even if it be eatable in case of need, according to the account of FABRICIUS[a], the truth of which is, however, denied by RICHARDSON[b], of its employment among the Greenlanders.

THE SLIMY SEA-SNAIL.

CYCLOGASTER GELATINOSUS.

Fig. 73.

Distance between the rent and the tip of the snout less than $^{1}/_{4}$ of the length of the body. Distance between the anal fin and the rent more than $^{1}/_{3}$ of that between the former and the tip of the snout. Only one nostril on each side, just in front of the eye, just above the middle of the latter or at its anterior upper corner. Rays of the dorsal fin from 50 to 55, of the anal fin from 44 to 48; both these fins posteriorly united to the caudal fin almost without visible division. Least depth of the tail about 3 % of the length of the base of the anal fin, which is more than $^{1}/_{2}$ the length of the body. Length of the caudal fin less than $^{1}/_{2}$ that of the head. Teeth in the cards of the mouth simple. Disk formed by the ventral fins equal in size to the eyes or slightly larger; the longitudinal diameter of the latter (in specimens about 60 mm. long) being about 6 or 7 % of the length of the body, from 27 to 33 % of the length of the head, or about $^{2}/_{3}$ of the breadth of the interorbital space as far as this is covered by the skin. Snout blunt; its length about equal to that of the ventral disk. Length of the pectoral fins from the upper angle about 16 % of that of the body or 70 % of that of the head. Distance from the tip of the snout to the dorsal fin from about 24 to 28 % of the length of the body, to the ventral disk 11 or 12 %, and to the anal fin from about 32 to 35 %. Body flabby, very slimy, partly transparent and of a yellowish or reddish colour, thinly punctated with dark brown, chiefly on the dorsal side.

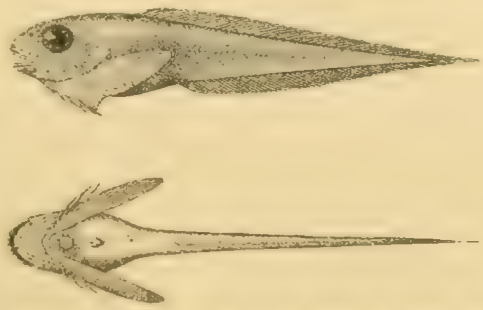

Fig. 73. *Cyclogaster gelatinosus*, natural size, taken in the Skager Rack between Arendal and the Skaw at a depth of 350—370 fathoms, in July, 1879. THÉEL and FORSSTRAND.

R. br. 6; *D.* 50—55; *A.* 44—48; *P.* 32–33; *V.* 6; *C.* $x+10+x$; *Vert.* 60—64.

Syn. *Cyclopterus gelatinosus*, PALL., *Spicil. Zool.*, fasc. VII, p. 19, tab. III, figg. 1—6; ID., *Zoogr. Ross. As.*, vol. III, p. 74;

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[a] "Editur coctus cum ovariis suis inter scorpios." *Fn. Gr.*, p. 137.

[b] *Fn. Bor. Amer.*, part. III, p. 264.

Reinh. (*Liparis*), Overs. Dansk. Vid. Selsk. Forh. 1842, p. 82; Jord., Gilb. (*Careproctus*). Bull. U. S. Nat. Mus., No. 16, p. 740; Gthr (*Liparis*), *Chall. Exp.*, *Rep. Scient. Res.*, *Zool.*, vol. XXII (*Deep Sea Fish.*), p. 67.

Liparis (*Careproctus*) *Reinhardi*, Kr., Naturh. Tidskr. Kbhvn, ser. III, vol. I, p. 252: Coll. (*Careproctus*), Vid. Selsk. Forh. Christ., 1880, No. 8, p. 1; Id., *Norsk. Nordh. Exped.* 1876—78, *Zool.*, *Fiske*, p. 57, tab. II. figg. 15 et 16; Lillj., *Sv.*, *Norg. Fisk.*, vol. I, p. 682; Ltkn (*Liparis*), *Dijmphna-Togtets Zool. bot. Udb.*, p. 152.

? *Liparis micropus*, Gthr, l. c., p. 66, tab. XII, fig. B.

Obs. Günther, as well as Jordan and Gilbert, has returned to Reinhardt's opinion that this species, as it occurs in Greenland, is the same as the Kamchatkan species described by Pallas, from Steller's notes and specimens. This point cannot be elucidated until well-preserved specimens have been obtained from the north of the Pacific, but if we keep in mind the variations to which the species of this genus are subject, and the geographical extension of the preceding species, every possible fact urges us to recognise this identity. Pallas also states, in his *Zoographia* (l. c.), that he has heard on trustworthy authority that the species also occurs in the White Sea. Whether Günther's *Liparis micropus* is not identical with this species, is a question that may well be asked; so exactly do his figures and description apply to the specimens we have examined. The number of the fin-rays (*D.* 35—37; *A.* 35—36) is the only character which might constitute a specific difference; but here a slip of the pen or some abnormity involuntarily suggests itself to us, for in no other *Cyclogaster* is the number of rays in the dorsal fin so like that in the anal; and even if the number of rays in the anal fin is as low as stated by Günther, still the other characters are against the recognition of the specific difference.

The Slimy Sea-Snail is distinctly a deep-sea fish. All the fishes of this description that we have previously treated of, are able to sustain life in the higher marine regions, or are not confined to so great a depth that the shape and structure of the true deep-sea fishes have been forced upon them. Among the peculiarities of the latter forms[a] we find, in the first place, their loose structure, which is not restricted to the skin, as in the other species of *Cyclogaster* (though in *Cyclogaster gelatinosus* it attains its highest development), but also affects the texture of the muscles and the bones. Steller and Pallas compare the organization of *Cyclogaster gelatinosus* in this respect to that of the *Medusæ*. Though the smaller specimens that we have examined, are of only slightly looser structure than similar examples of the preceding species, still the difference is pronounced enough to distinguish the species to some extent. Krøyer too, describes the skeleton as "remarkable for its loose, spongeous structure and consequent softness." Another characteristic of the deep-sea fishes — also a retention or even a higher development of a juvenile character — lies in the large muciferous pores and cavities in the head, belonging to the system of the lateral line; but even in this respect the Slimy Sea-Snail is to be regarded only as a more advanced form than the preceding species. This gradual progression in the same series of development, which further expresses itself most distinctly in the coalescence of the vertical fins, the greater number of rays in the dorsal and anal fins, and the decreasing depth of the tail, is all the more interesting as it is accompanied by the reduction of the apparatus of the ventral fins, and the removal in a forward direction of this apparatus and also of the vent, an alteration which is of systematical importance as a partial explanation of the relations between the jugular or the apodal forms and other types. During youth the position of the ventral disk in those specimens of *Cyclogaster gelatinosus* which we have examined, is only slightly different from that which it occupies in *Cyclogaster Montagui* or *Cycl. Fabricii*. In these cases the distance between it and the tip of the snout is 11 or 12 % of the length of the body (about 1 % less than in similar specimens of *Cycl. Montagui*), and only part of it lies under the posterior part of the eye. In older specimens, however, it is apparently moved considerably further forward: in Krøyer's specimen 183 mm. long, he states that it was only $4^{1}/_{3}$ mm. distant from the point of the lower jaw. This seems also to apply to the position of the vent. The distance between it and the tip of the snout in our specimens measures 20 or 21 % of the length of the body. According to Pallas, this proportion may sink to 9 %.

Assuming that the Kamchatkan species is identical with the Atlantic, the Slimy Sea-Snail attains a considerable size. The specimen described by Pallas in his *Spicilegia* was 495 mm. long, and in his *Zoographia* he says that the species often attains a length of 2 feet. In Scandinavia and the Atlantic Ocean it is extremely rare, and only small specimens are found. In 1879 the zoologists on board the gunboat *Gunhild*, Professor Théel and Doctor Trybom, took four specimens about 60 mm. long, in the month of July, about half-way between Arendal and the Skaw, at a depth of from 350 to 370 fathoms and on a bottom of fine, brown clay. On the Norwegian Arctic Expedition of 1876—78 three specimens between 56 and 79 mm. in length, were taken at a depth of from 263 to 658 fathoms, between Jan Mayen and Bear Islands. As we have stated above, the three specimens between 51 and 89 mm. in length which were taken on the voyage of the *Knight-Errant* in 1880, at a depth of 540–608 fathoms, between the Faroe Islands and the Shetlands, and described by GÜNTHER under the name of *Liparis micropus*, probably belong to this species. The Dijmphna Expedition brought home from Kara Sea a specimen taken at a depth of 64 fathoms. REINHARDT and KRØYER possessed specimens from Greenland. Nothing more is known of its manner of life than that, like other deep-sea fishes, it may sometimes be driven in some way from its true home to the higher marine regions, where it helplessly drifts ashore before the wind, as described by PALLAS in Kamchatka. The spawning-season occurs, according to STELLER'S observations, in May, and in the larger females the eggs are then of the size of a pea. In the small females the eggs are also smaller: COLLETT found them to be about as large as a poppy-seed. *Cyclogaster gelatinosus* is of still less economical value to man than the preceding species: even the Siberian dogs, says STELLER, however hungry they may be, refuse to eat it.

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[a] Cf. Günther, *Introd. Study of Fish.*, pp. 299 etc. (*Handb. Ichth.*, pp. 199 etc.) and *Voy. Challenger*, *Rep.*, *Zool.*, vol. XXII, pp. XXIV etc.

GENUS CYCLOPTERUS.

Body bulky, short and thick (during youth, however, much the same as in the preceding genus). Skin fairly hard, and rough with spines and spinous tubercles (in youth, however, smooth). Two dorsal fins, but the anterior distinct only during youth, in older specimens to a greater or less extent, sometimes completely, overgrown and hidden by the skin. Branchiostegal rays well-developed. Skeleton weakly ossified; vertebræ at most 30.

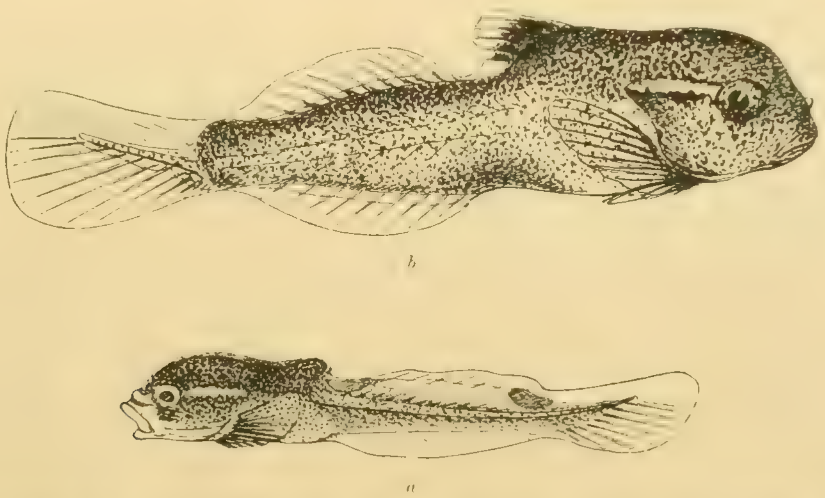

Fig. 74. Two early juvenile stages of *Cyclopterus lumpus*: *a*: at a length of 4 mm.; *b*: at a length of 5 mm. After A. AGASSIZ.

The slight granulation of the skin which sometimes appears in adult specimens of the preceding genus, and the curve in the upper margin of the dorsal fin which we find in *Cyclogaster Montagui* or, still deeper, in the Californian *Cycl. mucosus*, are sufficient indications of the close relationship between the preceding genus and *Cyclopterus*. This relationship appears still more distinctly from a study of the juvenile forms of the latter genus, which in their earliest stages of development (fig. 74) are elongated like *Cyclogaster*, and may retain the nakedness of the skin even after they have attained their own proper form in other respects. Like the preceding genus, too, *Cyclopterus* is furnished with an osseous connexion between the suborbital ring and the preoperculum, though from the almost membranous texture of the bones this connexion is easily overlooked[a]. These resemblances speak strongly in favour of the retention of these two genera in the same family, even without their separation into distinct subfamilies, in spite of the great external differences between them in an adult state. Even *Cyclopterus* partially retains the external similarity to the tadpole; but the marked development of the forepart of the body and its deeper (shorter) form, together with the singular covering of the skin, give *Cyclopterus* a greater resemblance to *Ostracion* or *Diodon*, to which fishes this genus was partly united even by ARTEDI and LINNÆUS[a].

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[a] It is distinctly and correctly shown, however, in ROSENTHAL'S *Ichthyotomische Tafeln*, tab. XIX, fig. 1.

The genus contains only two species, both of northern and Arctic origin, but only one, the more southern species — distinguished by the shorter head, the larger gill-openings, the longer rays in the second dorsal, anal and caudal fins, the more or less complete dermal covering of the first dorsal fin, and the dermal plates, arranged partly in rows, on the body — is known to belong to the Scandinavian fauna.

THE LUMP SUCKER (SW. SJURYGGEN).

CYCLOPTERUS LUMPUS

Plate XVI.

Length of the head less than $^1/_3$ of that of the body. Least depth of the tail more than $^1/_4$ of the length of the head, and the length of the caudal fin more than $^3/_5$ of the latter. Gill-openings extending downwards in front of the upper part of the base of the pectoral fins. Longest rays in the second dorsal and the anal fins measuring more than 14 % of the length of the body. First dorsal fin, in adult specimens, so completely overgrown that sometimes no free rays are externally visible. The large dermal plates arranged in distinct, longitudinal, elevated rows on the body.

R. br. 6; *D.* (6—8) $\frac{1}{(9)10}$; *A.* $\frac{1}{9(10)}$; *P.* 20; *V.* 6; *C.* $x + 9 + x$; *Vert.* 28 l. 29.

Syn. *Cyclopterus*, ART., *Gen. Pisc.*, p. 61; *Syn. Pisc.*, p. 87; *Cyclopterus s. Lumpus*, LIN., *It. Öland*, p. 110; *Fn. Suec.*, ed. I, p. 103; *It. Scan.*, p. 188; ASCAN., *Icon. Rer. Nat.*, tab. XXXIV.

Cyclopterus heptagonus, LIN., *Mus. Ad. Frid.*, I, p. 57.

Cyclopterus Lumpus, LIN., *Syst. Nat.*, ed. X, tom. I, p. 260; FABR., *Fn. Groenl.*, p. 131; MOHR, *Isl. Naturh.*, p. 61; RETZ., *Fn. Suec. Lin.*, p. 327; PALMSTR., QVENS., SW., *Svensk Zool.*, No. 52; EKSTR., Vet.-Akad. Handl. 1831, p. 100; PALL., *Zoogr. Ross. As.*, vol. III, p. 72; NILSS., *Prodr. Ichth. Scand.*, p. 61; KR., *Danm. Fiske*, vol. II, p. 490; NILSS., *Skand. Fn., Fisk.*, p. 232; GTHR, *Cat. Brit. Mus., Fish.*, vol. III, p. 155; MGRN, *Finl. Fisk.* (disp. Helsingf.), p. 17; LINDSTR., Gotl. L. Hush. Sällsk. Årsber. 1866, p. 16 (sep.); COLL., Forh. Vid. Selsk. Christ. 1874, Tillægsh., p. 63; SEIDL., *Fn. Balt.*, pp. 29 et 122; MALM, *Gbgs, Boh. Fn.*, p. 445; BNCKE, *Fisch., Fischer., Fischz. O. und W. Preuss.*, pp. 85 et 201; WINTH., Naturh. Tidskr. Kbhvn, ser. 3, vol. XII, p. 19; MOR., *Hist. Nat. Poiss. Fr.*, vol. III, p. 349; DAY, *Fish. Gt. Brit., Irel.*, vol. I, p. 179; MELA, *Vert. Fenn.*, p. 284, tab. IX; MÖB., HCKE, *Fisch. Osts.*, p. 58; JORD., GILB., Bull. U. S. Nat. Mus., No. 16, p. 747; LILLJ., *Sv., Norg. Fisk.*, vol. I, p. 718; HANSEN, *Zool. Dan., Fiske*, p. 39, tab. VI, figg. 11 et 12.

Cyclopterus minutus, PALL., *Spic. Zool.*, fasc. VII, p. 12, tab. III, figg. 7—9; MÜLL. (RATHKE) (*Gobius*), *Zool. Dan.*, fasc. IV, p. 38, tab. CLIV. B, figg. 1—3; — juv. hujus spec., vide FRIES, Vet.-Akad. Handl. 1838, p. 226, tab. IV, fig. 1, a—c; v. DÜB., KOR., ibid. 1844, p. 116, tab. III, fig. 8, a—c.

Cyclopterus pavoninus, SHAW.; *Cycl. coeruleus*, MITCH.; *Lumpus Anglorum* (WILLUGHBY), DEKAY, STORER; *Cyclopterus coronatus*, COUCH: — vide DAY, l. c.

Adn.: Forma *baltica* characteribus juvenilibus et pinnis *D* et *A* altioribus distinguitur.

In Sweden and on the coasts of Europe the Lump Sucker probably never exceeds a length of 6 dm. and a weight of $5^1/_2$ kgrm., and is generally much smaller[b]. The females are, as a rule, larger and, especially during pregnancy, thicker than the males. A gravid female 46 cm. long, according to NILSSON, weighs $3^2/_5$ kgrm. According to BUCKLAND, a female 5 dm. long and 3 dm. deep (thick) weighs nearly 5 kgrm., the roe forming 680 grm. of this weight. In shape the Lump Sucker is one of our most singular fishes, being bulky and polygonal, as the Swedish name shows, for by *sjurygg* (Seven-back) is only meant that it has seven longitudinal ridges, marked by large, spinous plates, on the body, which is scaleless, but rough with small spines. One of these ridges runs in the form of a cartilaginous hump along the dorsal line behind the head, and generally invests the whole of the first dorsal fin, being double between the latter and the second dorsal fin. Another ridge runs on each side of the body from the upper anterior corner of the eye, between the posterior nostril and the latter, and then advances over the eye, being fairly straight or somewhat curved above the pectoral fins, and situated at the bottom of the upper third of the body or a little higher, out along the tail to the base of the caudal fin. Another ridge runs fairly parallel to the latter. It begins just behind the gill-opening, about half-way between its upper corner and the upper angle of the pectoral fin, and advances on the abdominal region, along the middle of the side, but on the caudal region at about the top of the lower third of the tail. The lowest ridge runs on each side of the belly itself, which during youth, after the formation of this ridge, is flat or even concave between the latter and its correspondent on the other side of the body — as if this part of the belly were a continuation of the ventral disk — until it becomes rounded when the organs of generation reach maturity. This lower ridge is generally continued, after a short interruption, by a row of small protuberances along the base of the anal fin; and a similar row of protuberances — or even two — generally appears along the base of the second dorsal fin. A row of two or three osseous tubercles generally runs back along the branchiostegal membrane, below the cheek, from the end of the lower jaw. The depth of the body varies considerably with the growth of the dorsal hump and the greater or less tumidity of the belly; in old males it may often rise to about 45 % of the length of the body, and in gravid females to more than half the latter. This is also true, though in a less degree, of the greatest thickness of the body (across the belly), which in old specimens varies between about 25 and 27 % of the length of the body. The least depth of the body too, just in front of the caudal fin, generally undergoes even relative increase with age. It is usually greater in the male than in the female, and varies between 8 and 10 % of the length of the body. The head is fairly large, generally more so in the males, but its relative length decreases with age, varying in full-grown specimens between $26\frac{1}{2}$ and 28 % of that of the body. The cheeks fall perpendicularly from the broad and flat forehead — the breadth of the interorbital space at the middle of the eyes, in full-grown specimens, varies between about 60 and 70 % (58·3—71 %) of the length of the head. The abruptly rounded snout is short, but its breadth renders it large: its point is occupied by the mouth, which is turned somewhat upwards, and the breadth of which — generally greater in the male than in the female — varies between about 55 and 65 % of the length of the head. Both jaws, with their thick lips project equally far forward, when the mouth is closed, but when the latter is open, the lower jaw proves to be slightly the longer. The jaw-teeth are small and pointed, in younger specimens forming two or three rows in front only, and set in a simple row behind; but in old specimens set in cards which grows gradually narrower behind, and are broader (contain more rows) in the upper jaw than in the lower. The thick tongue and the palate are toothless; but the pharyngeal bones, both above and below, are set with oblong cards of teeth. The nostrils are double, both pairs being sometimes raised in a tubular shape, but this is the case, as a rule, only with the anterior pair, which are the larger, and lie on a level with the middle of the eyes, the distance between them and the latter being about equal to the diameter of the eye (somewhat less in young specimens). The eyes are laterally set and mobile[a]; they are situated high up, below the margin of the forehead and just in front of the middle of the head, in full-grown specimens generally measuring from about 17 to 22 % of the length of the latter — in old specimens from greater depths this proportion may rise to 25 %, and in young specimens the eyes are, as usual, larger. In young specimens between 24 and 28 mm. long we have found them to measure as much as $36\frac{1}{2}$ and 31 % of the length of the head. The gill-opening begins superiorly on a level with the superior margin of the eye, and ends below, in front of the base of the pectoral fins, on about a level with the mouth. Below this point the thick branchiostegal membrane hangs like a dermal fold straight across the throat.

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[a] *Orbis* ranæ rictu and *Orbis spinosus* in CLUSIUS, WILLUGHBY and RAY, *Crayracion* ore rictu ranæ and *Crayracion* scutatus in KLEIN, are synonymous with *Ostracion* rotundo-oblongus, tuberculis utrinque, pinna dorsi longissima and *Ostracion* subrotundus, aculeis undique brevibus planis, ventre glabro, in ARTEDI (*Gen.*, p. 59; *Syn.*, p. 86), and *Diodon raninus* and *Diodon spinosus* in LINNÆUS (*Syst. Nat.*, ed. X, tom. I, pp. 335 and 336), both of which were subsequently referred by LINNÆUS (*Syst. Nat.*, ed. XII, tom. I, p. 414) to *Cyclopterus lumpus*.

[b] MÖBIUS and HEINCKE state the maximum length of the Lump Sucker at 12 dm.; STORER (Mem. Amer. Acad., VIII, part. 2, p. 404) states that the largest specimen he had seen weighed $18^3/_4$ lbs. = $8^1/_2$ kgrm. The largest specimen belonging to the Royal Museum is 485 mm. in length, and was taken in Norwegian Finmark (1837, S. LOVÉN).

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[a] "Je ne connais aucun poisson qui tourne ses yeux brillants avec tant de promptitude": ASCANIUS.

The pores belonging to the system of the lateral line are small, and in old specimens hardly distinguishable.

The pectoral fins and the disk of the ventral fins are of the same structure and shape as in the preceding genus; but the former are not so broad — their upper angle lying lower down, and the number of rays being only 20 — and are without the incision in the lower posterior part of the margin. The distance between the pectoral fins at the bottom is scarcely equal to the diameter of the eye; when laid back, the fins do not extend to the vent, the length of their upper part in full-grown specimens being 14 or 15 % (13·8—15·1 %) of the length of the body. In specimens from the Baltic, however, the length of these fins is relatively greater (17—19 %), and also in young specimens: in specimens between 24 and 28 mm. long we have found them to measure 17·5—17·8 % of the length of the body. They are also, as a rule, longer in the male than in the female. The length of the oval disk formed by the ventral fins is also relatively greater in young specimens than in old and, generally, in the male than in the female, its longitudinal diameter, including the dermal rim, varying in adult specimens between about $14^1/_2$ and $19^1/_2$ % of the length of the body, and in young specimens between 20 and $21^1/_2$ thereof. In the hind part of the dermal margin we find the tips of the four posterior (inner) rays on each side[a]. In the old males, which are furnished with a genital papilla behind the vent, the latter lies about half-way between the adhesive disk and the anal fin; while in young specimens and the females it generally lies nearer the latter. Hence it follows, as a rule, that the length of the pectoral fins in young specimens and those from the Baltic (see above) is greater than the distance between the vent and the anal fin, but in the adult Atlantic specimens less.

The first dorsal fin, with from 6 to 8 simple, but soft, spinous rays, is covered in old specimens, as we have mentioned above, by the more or less cartilaginous hump[b], which develops during growth. This hump generally rises almost evenly from the occiput or forms a slight break at its origin; but sometimes, especially in old males, it may rise like a cock's-comb, or at least in a sharply marked semicircle, to a height equal to the depth of the head at the occiput or that of the body at the termination of the abdominal cavity. The alteration in the shape of the body thus caused is so great that PALLAS and his successors long believed that the young specimens were a distinct species (*Cyclopterus minutus*, Plate XVI, the three middle figures). FRIES was the first to demonstrate that these young examples belong to the species now under consideration, in spite of their rounded back and distinct anterior dorsal fin, with visible rays[c]. At this period, before the rows of tubercles appear, the skin is also smooth; and sometimes, as V. DÜBEN and KOREN have shown, specimens 30 mm. long may be "entirely smooth and even, without the least trace of tubercles, spines or ridges". For a long time, too, the tips of the last rays in the first dorsal fin may be distinguished, though not with ease; this seems to be most persistent in specimens from the Baltic.

The second dorsal and the anal fins are very like each other, the first (simple and unarticulated) and the last (articulated and generally simple) rays being the shortest, and the fourth (the first branched) ray the longest. The remainder of the margin is rounded or almost straight. The base of the former fin, the length of which varies between 15 and 20 % of that of the body, and undergoes greater increase with age, even relatively than the length of the anal fin, is always longer than that of the latter, which varies between about 14 and $15^1/_2$ % of the length of the body. During youth the height of each of these fins is equal to its base; in old specimens, on the other hand, the height of the anal fin is greater than the length of its base, but in the second dorsal fin the proportions are reversed. Specimens from the Baltic are apparently marked by the still more considerable height of these fins (more than 18 % of the length of the body), and hence it follows that in their case, even in old specimens as well as during youth, the height of the second dorsal fin is equal to the length of its base. The caudal fin is also slightly rounded or sometimes almost truncate: the middle rays are slightly longer than the outermost branched rays, their length, which relatively decreases with age, varying between 23 % (in young specimens) and 16 % (in old), or, by our measurements, exactly 22·8 % and 16·2 % of the length of the body, or 71 % and 65 % (71·1 and 64·5 %) of the length of the head. The Baltic specimens are distinguished, however, by longer rays in this fin also, the length of the caudal fin at the middle in specimens 150—170 mm. long being about 18 % (18·1—18·4) of that of the body or 66 % (65·6—65·8) of that of the head. In the caudal fin we may sometimes find 3 supporting rays above and below; but as a rule, only one of these rays can be distinguished at the top of the fin, and two at the bottom. Most of the nine true rays are simple during youth, and in old specimens the outermost ray on each side or on the one side is simple or at least indistinctly branched. All the rays in the second dorsal, anal and caudal fins are rough with small spines, but the membrane between the rays is smooth and, especially in the caudal fin, very ductile.

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[a] According to BLOCH (*Fische Deutschl.*, III, p. 104), HANOW estimated that the adhesive power of the disk in a Lump Sucker 8 Prussian inches (21 cm.) long represents a lifting-power of $74^1/_2$ Zollpfund ($34^8/_{10}$ kgrm.). PENNANT states (*Brit. Zool.*, III, p. 118) as a proof of this power that he once placed a fish of this species, just caught, in a pail containing several gallons of water, and by taking hold of the tail of the fish was able to lift pail, water and fish without forcing the latter to relinquish its hold of the bottom. It is, however, the adhesion of the disk alone, without any special exertion on the part of the fish, that is at work here, for BUCKLAND (*Nat. Hist. Brit. Fish.*, p. 126), on cutting off the adhesive disk of a dead Lump Sucker 5 kgrm. in weight, and pressing it against a damp window-sill, found that it was only with the greatest effort he could just lift it straight up, though laterally it did not offer the slightest resistance.

[b] A similar formation appears during the spawning-season in the males of the Pacific Salmons.

[c] Even ASCANIUS, however, had seen and identified these young specimens, though his figure of one of them (l. c.) is not very instructive.

Among the internal organs the intestinal canal is remarkable for its great length and the number of the pyloric appendages. The œsophagus is wide and straight, but the stomach curves forward and extends to the diaphragm, where the pylorus with its numerous appendages occupies the right side of the abdominal cavity, the liver lying chiefly to the left. The intestine itself lies in a number of coils, its length being considerably greater than that of the body. The urinary bladder, which lies at the termination of the abdominal cavity, behind the vent, is also remarkably large. During the spawning-season the generative organs are considerably tumid.

The coloration in the old specimens is bluish gray, darker (blackish gray) on the back, with large dark spots on the sides, and almost everywhere strewn with small black dots on the skin, most of the spines and plates being tipped with brown. During the spawning-season these colours are intensified, and the males are marked by their red belly, as shown in v. Wright's two figures of old specimens (Plate XVI, figs. ♂ and ♀). "The iris is brassy yellow, with a dash of a darker tint," says Ekström, "but when the fish has been out of the water for some length of time, the iris turns silver-white." The living young specimens, in which, according to Möbius and Heincke[a], we find the liveliest play of colour, are thus described by Fries[b]. "The whole fish is of a greenish yellow colour, thickly punctated with a number of fine, dark dots, visible only under the magnifying-glass. A narrow, bluish stripe, with a silvery lustre, follows a somewhat winding course on each side from the point of the nostrils to the eye and thence across the sides of the head to the point of the gill-cover. In some specimens this stripe begins on the upper jaw. The eyes have an orange ring next the pupil, and the rest of the iris is very thickly punctated with dark brown, on a varying golden and silvery ground. All the fins are transparent, with the exception of the anterior dorsal, which is of the ground-colour of the body, and in some specimens has a little silvery spot or similar transverse band near its point, and of the collar running from the pectoral fins, which is of a handsome flame-yellow colour, and in some specimens crossed by a silvery transverse band. Sometimes, too, we find small silvery spots, inconstant in number and shape, at the base of the pectoral fins, beside the adhesive disk, and on the dorsal edge behind the posterior dorsal fin[c], but their occurrence is only partial in some cases."

The difference in the coloration has given rise to different names for the sexes. In Scania, as in Denmark, the male is called *Stenbit* (Stone-biter), the female *Qvabbso* (Angler-sow), these names being also used, according to Malm, on Gäsö in Bohuslän. In the north of Bohuslän, on the other hand, the female is said to be called *Rånka*, a reminiscence of the Norwegian name for the species, *Rogn-kal* (Roe-fellow) for the male and *Rogn-kexe* (Roe-hag) for the female. In the Baltic the species is more commonly known as *Sjurygg*[d], as we are told even by Artedi and Linnæus, and also, in Gothland, *Stainbäjtare* (= Stenbit) and on Fårö *Snorfojbul* (Snivel-fellow) and *Stainbuck* (Stone-buck), according to Lindström. We have thus every reason to suppose that the Lump Sucker has attracted considerable attention on the part of fishermen and others, in spite of the insignificance of its economical value. The attention paid to it is, therefore, due chiefly to its singular appearance and manner of life.

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[a] *Fische der Ostsee*, p. 57.

[b] Vet.-Akad. Handl. 1838, p. 231. Cf. Plate XVI. figg. *juv.*, which are copied from v. Wright's drawings executed for Fries.

[c] See above, fig. 74, *a*.

[d] Also *Lumpfisk*, according to Ekström.

The Lump Sucker occurs from very deep water up to the littoral region, where it prefers a rocky or stony bottom. The Royal Museum has received specimens from a depth of between 100 and 150 fthms off Jäderen on the coast of Norway, and of between 100 and 200 fthms, on the Jutland Reef in the North Sea. Though a bottom-fish and thus of sluggish temperament, it may sometimes be found swimming freely about in the open sea. This does not depend entirely on the circumstance that it attaches itself to floating objects and drifts about in their company, for it also displays considerable activity in the pursuit of its prey and on its migrations to the spawning-place. EKSTRÖM mentions its habit of attaching itself to the wooden floats or buoys (*skötklabbar*) used to support the Herring-nets (*skötarne*). COUCH[a] states, on good authority, that a Lump Sucker has been taken firmly attached to a Mackerel caught in a drift-net where the water was considerably deep. DAY also gives two observations, made by Mr. CORNISH[b], of the capture of the Lump Sucker in Mackerel-nets drifting at the surface. On the voyage of the *Ingegjerd* and *Gladan*, the two ships of the Swedish expedition to Greenland in 1871, a young specimen 33 mm. long was taken in a surface-net in the neighbourhood of Newfoundland[c]. This species is most often taken, however, though only by accident, in nets sunk to the bottom or in trawls.

The geographical range of the Lump Sucker extends from Greenland, the extreme north of Norway[d], and the White Sea[e] southwards to the Bay of Biscay, on the east of the Atlantic, and to Chesapeake Bay, on the west. In Bohuslän it is far from rare, up to the Laminaria region (MALM). In the Baltic, according to MELA, it occurs up to the top of the Gulf of Bothnia, where it is said, however, to be rare. As LILLJEBORG has already remarked, however, the Baltic form is distinguished by several peculiarities; and we have above given all the instances of these that we have found in the specimens between about 140 and 170 mm. long, which the Royal Museum has acquired from Bråvik and the island-belt of Stockholm. Most of these peculiarities indicate a persistency of the juvenile characters fully analogous to the relation between the Baltic Herring and the common form. One of these characters lies in the greater length of the pectoral fins, in which respect the Baltic form approaches the more arctic *Cyclopterus spinosus*. Others, however, as for instance the greater height of the second dorsal and the anal fins, contradict this impression and suggest a distinct direction of development, even if this be not far enough advanced to justify a distinction of species. According to BENECKE the Lump Sucker attains a length of from 20 to 30 cm. on the coast of Prussia. Off Mörkö EKSTRÖM never found specimens more than 15 cm. long. In the Baltic it probably does not attain so great a size as in the Atlantic. Even in Kiel Bay, however, according to MÖBIUS and HEINCKE, it may be 40 cm. in length. The Danish authors, after KRØYER, state the maximum length of the female at 45 cm. and of the male at about 30 cm. MALM records the capture of a female 48 cm. long in the island-belt of Bohuslän.

The Lump Sucker has sometimes been met with in fresh water, at least at the mouths of rivers: DAY mentions an instance of this at King's Lynn in Norfolk, and MÖBIUS and HEINCKE another at the mouth of the river Weser.

The spawning-season of the Lump Sucker occurs at the beginning of spring, in the Baltic at the end of April or beginning of May, according to EKSTRÖM, in Bohuslän at the same period or, according to an observation recorded by MALM, at the middle of May, and in Greenland, according to FABRICIUS, at the end of May or beginning of June. At this time or a little earlier the Lump Sucker migrates from deep water to the spawning-places, at a depth of some fathoms and where the bottom is overgrown with seaweed, sometimes close to low-water mark, where the bottom is almost dry during spring. Here the female lays her numerous[f], red[g] eggs, and after her follows the male to fertilize and watch them. Even FABRICIUS describes the vigilance and courage displayed by the male in the performance of this duty. JOHAN PERSSON, a fisherman of Sydkoster in Bohuslän, as MALM relates, observed the spawning of the Lump Sucker for three years running in the same cleft in the rocks, at a depth of 3 or 4 fathoms. After the roe had been deposited, the male posted itself "a couple of feet away and blew on the roe, which it defends from all enemies, defeating the attacks even of the crab." It is probable, however, that the female also shares this duty. From Gamrie, in Banffshire, HARRIS[a] states: "Upon this coast their *nests* are almost invariably to be met with in rocky places, a little beyond low-water mark. There is also this peculiarity, that the sites of these are usually cavities from eight to ten inches in diameter, opening horizontally into the water. Mr. WEST, of Pennan (Zool. 2998), informs me, that in one case he came upon a *hen* seated on her nest, just, he supposed, as she had completed the process of spawning. She adhered very tenaciously, manifesting at the same time considerable intrepidity, which seemed to be shared by her companion, the *cock*, who, during the struggle, kept close by, flitting through and through the water in a state of violent agitation." The fry grow slowly, but vary in this respect. During the first year, in the majority of cases, they probably do not exceed a length of 20 mm. On the voyage of the gunboat *Gunhild*, in 1878, young specimens from 10 to 12 mm. long were taken on Lilla Middelgrund, at a depth of between 10 and 12 fathoms, on a stony and sandy bottom, on the 12th of July, and on the 16th of the same month another specimen 16 mm. long was caught S.W. of Kullen, at a depth of 13 fathoms, on a bottom composed of blended sand and clay. On the 4th of August, 1865, Dr. A. V. LJUNGMAN took young specimens from 12 to $18^1/_2$ mm. long, at the surface of the open sea, west of Koster, and on the 21st of the same month a young specimen $16^1/_2$ mm. long, at a depth of between 3 and 8 fathoms, on a clayey bottom. In March, 1882, Mr. C. A. HANSSON caught a Lump Sucker 28 mm. long in Koster Fjord. This specimen, when compared with the others mentioned above, must naturally be assumed to have belonged to the previous year, as well as the fry between 19 and 31 mm. long which FRIES (l. c.) took in such large numbers in a bottom-net, in Gullmar Fjord, in the month of April. According to this assumption too, the small, light sea-green specimens, strewn with black dots and about 75 to 100 mm. long, which are stated by FRIES to be taken in small numbers in autumn, in the seines, on the coast of Bohuslän, must also date from the spawning-season of the preceding year.

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[a] *Fish. Brit. Isl.*, vol. II, p. 185.

[b] *Zoologist*, 2nd ser., vol. VIII and IX, pp. 3532 and 4961.

[c] Lat. 47° 35′ N., long. 52° 34′ W. (26 Aug , 1871, JOSUA LINDAHL).

[d] Where, according to COLLETT, however, it is less common than in the south of Norway.

[e] There is no record of its occurrence in Spitzbergen, where the genus is represented by the other species, *Cyclopterus spinosus*.

[f] The number of eggs and, probably, their size vary with the size of the parent fish. In a female weighing 5 kgrm. BUCKLAND (l. c.) counted about 194,000 eggs. The entire roe weighed 730 gram.

[g] In the ovaries, according to FABRICIUS, the colour of the eggs varies considerably, being white, red, yellow, blue or green.

The Lump Sucker feeds, according to EKSTRÖM, on crustaceans, worms and *Medusæ*, the latter entering into its diet, as LILLJEBORG has remarked, chiefly for the sake of the crustaceans (*Hyperidæ*) which live in their body. Its own most formidable enemy is said to be the seal, which skilfully skins it from head to tail, leaving both these parts fast to the skin[b]. As human food the reputation of the Lump Sucker varies. "The flesh, when boiled, is flabby," says EKSTRÖM, "is always rather tough, and in my opinion is far from appetising." In France it is not eaten: "the flesh," says MOREAU, "diffuses an odour which is by no means pleasant." In Scotland, however, many persons thoroughly appreciate it, at least before the spawning-season, though the female is less liked than the male. "Here," writes MALM of Bohuslän, "no method of preparing this fish for food is generally known, or of removing the skin, which is much thicker than in the majority of fishes, and almost cartilaginous. The Lump Sucker is, therefore, not much in demand, and is usually sold at a price which seems trifling when we consider its value as a wholesome and agreeable article of food."

In the pharmacopœia of former times the Lump Sucker held a high place[c]. "The few specimens that are caught here," writes EKSTRÖM in the *Fauna of Mörkö*, "are never used as food. They are employed only as a remedy for ague. For this purpose the fish is thoroughly dried in an oven, and pounded to a powder. The powder is taken in corn-brandy, in doses of a teaspoonful."

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[a] *Zoologist*, 1851 (IX), p. 3157.

[b] HARRIS, l. c.

[c] "Pulvis contra Tertianam vulgo adhibetur": LINNÆUS, *Fn. Svec.*

Fam. GOBIESOCIDÆ.

Body broad, tadpole-like, depressed in front and terete behind. Scales wanting. No distinct lateral line. No branched fin-rays. Only one dorsal fin, corresponding to the posterior dorsal fin in the preceding forms, and composed of flexible, simple and articulated rays, generally without spinous rays[a]. *Anal fin similar in shape and opposed to the dorsal, but shorter (with fewer rays). Ventral fins proximally distinct, but in front united by a dermal fold and behind surrounding a double adhesive disk, the frame of which is formed anteriorly by the pelvic bones and posteriorly by the postclavicular bones, which project downwards behind the former. Fourth branchial arch with no lamellæ or only one row. Pseudobranchiæ present, but most often only rudimentary. Six or five branchiostegal rays. Air-bladder and pyloric appendages wanting. No osseous connexion between the suborbital ring and the preoperculum. Palatine and vomerine teeth wanting. Anal papilla present, at least in the males.*

It is indeed true, as Günther has remarked, that, in the structure of the ventral disk, these fishes are entirely different from *Cyclogaster* and *Cyclopterus;* but their relation to the latter in this respect, to a certain extent, corresponds to that of *Callionymus* to the Gobies, and they have many striking resemblances to *Callionymus.* They may, therefore, with reason retain their place in the Gobiomorph series, as was also the opinion of Joh. Müller, as cited above.

On merely external examination we easily find that the adhesive disk is of a more complex structure than in the preceding family, and is formed of two distinct parts, an anterior and a posterior, though the boundary between them is not always marked throughout the exterior. The skin of the adhesive disk is covered with a mosaic of small tubercles, and underneath the skin is a well-developed layer of muscular tissue. The anterior margin is formed by the flat, extended rays of the ventral fins and the membrane which unites them to each other, and anteriorly forms a broad connecting-link between the two ventral fins. As in the Dragonets, the same membrane posteriorly runs up the lower part of the front of the pectoral fins, which in several of the forms belonging to this family is also furnished with a perpendicular dermal fold lying in front of this point. The posterior division of the adhesive disk is furnished with a separate dermal rim, which is extended by cartilaginous rods exactly resembling fin-rays, and the more liable to be mistaken for the latter as the rim is turned upwards on each side of the body behind the pectoral fin, the fish being thus apparently possessed of two pairs of pectoral fins, the one just in front of and covering the other. This is due to the fact that, just as the pelvis forms the osseous framework of the anterior division of the adhesive disk, the posterior division is also furnished with an osseous framework, which belongs to the lower part of the postclavicular bone suspended on each side of the body within the shoulder-girdle (the clavicular bones). But the cartilaginous rods issue from the cartilaginous disk which lies in the skin outside (beneath) the postclavicular bone, and thus do not correspond to the rays of either the pectoral or the ventral fins. The true rays of the ventral fins are four in number, simple and articulated, the penultimate ray being the longest; and in front of them we find an unarticulated, discous, spinous ray, broad at the top, often triangular and geniculate, and hidden in the skin. In a groove in the anterior side of the latter Günther also found a thinner ray concealed, "quite free and not joined to the pelvic bone." The number of ventral rays normal in the Acanthopterygians (6) may thus occur in this family too.

The shape of the whole head, the position of the eyes (though they are further apart), the shape and inferior position of the thick-lipped and protrusile mouth, and above all, in most of the forms, the mobile spine or posterior tip of the lower posterior corner of the preoperculum, all still further enhance the resemblance of these fishes to the Dragonets. The *Gobiesocidæ* are thus distinguished from the latter chiefly by the highest development of one organ, the adhesive disk, and the total lack of another, the first dorsal fin, the reduction of which, however, was already foreshadowed in the Gobioid family. Thus, the gain of the ventral part is the loss of the dorsal.

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[a] Sometimes, however, as in *Gobiesox nudus* (Lin., nec Gthr), there is one spinous ray, unarticulated, but flexible at the tip, at the beginning of the dorsal fin. Müller and Troschel (*Horæ Ichthyologicæ*, Heft. III, p. 17) mention *two* similar spinous rays at the beginning of the dorsal fin in *Chorisochismus dentex*.

With regard to the former species, it should be stated, however, that the original specimen of Linnæus's *Cyclopterus nudus* (*Mus. Ad. Frid.*, p. 57, tab. 27, fig. 1) is still preserved in the Royal Museum, and is evidently the same species as that described by Günther (*Brit. Mus. Cat., Fish.*, III, p. 502) under the name of *Gobiesox macrophthalmus.* Several additional specimens of this last species have been forwarded to the Royal Museum from St. Bartholomew (W. Indies) by Dr. A. v. Goës.

The jaw-teeth are usually small, but comparatively strong, conical and set in one or a few rows, though in the front of the jaws they are sometimes cardiform, or some of them are developed into sharp and strong, compressed incisors. The intestinal canal is short and simple, but internally furnished with broad and numerous folds of the mucous membrane. The liver is large and bilobate. The gall-bladder large. Among the anatomical characteristics Günther has remarked a well-developed omentum[a] in some species, and lacrymal sacs, as he terms them[b], at the eyes of one of the species. With regard to the external characteristics we may remark that the predominant colour in most of the species is red.

The family contains about 20 species, distributed by Günther among 9 genera[c], and occurring in the Temperate Zones of both the Southern and Northern Hemispheres, but rare within the Tropics. Its members, most of which are small fishes, usually lie very still, with their adhesive disk fast to the bottom, sometimes so close to shore that they are left dry by the ebb. The larger species, it is true, live in deeper water, and even the small ones may have their usual haunt at a depth of as much as 30 fathoms; but no true deep-sea species is known.

Genus **LEPADOGASTER.**

Postclavicular part of the adhesive disk completely separated, even externally, from the pelvic part, the dermal rim of the former being transversely pendent, even in front, at the boundary between it and the latter. No special dermal fold on the front of the base of the pectoral fins, or only a slight trace thereof. No preopercular spine. Gill-opening perpendicular, the branchiostegal membrane being coalescent with the broad isthmus, without any dermal fold across the throat. Fourth branchial arch with a simple row of lamellæ. Six branchiostegal rays on each side. Snout depressed and more or less elongated. Jaw-teeth set laterally in a simple row, and anteriorly cardiform. No incisors. Dorsal and anal fins without spinous rays, but with the rays distinctly articulated. Anal papilla present both in the female and in the male[d].

This genus, which was established in 1770 by Gouan[e], really belongs to the Mediterranean, to which locality Canestrini[f] ascribes 6 species, half of which, however, he refers to a distinct genus, *Mirbelia*, distinguished by the marked separation of the vertical fins from each other, whereas, in the other species, they are more or less closely united. The insignificance of this generic character, however, we have already seen in the species of the genus *Cyclogaster*. Three species occur on the coasts of Great Britain and Ireland, and one of these also belongs to the Scandinavian fauna. "They are peaceable and gregarious," says Risso[g] of these fishes, "and generally collect in small companies which live together. Their scaleless, slippery body glides through the sand and pebbles where they make their home. Their food is composed of worms (*Nereidæ*) and other small creatures." That they live on other food as well, is apparently shown, however, by the method of catching them which he describes. "In order to procure these fishes," he says, "a hole may be scraped in the sand, and a dead fish laid there. When the Suckers (*Lepadogaster*) scent the fish, they attach themselves to it, and begin their meal on the flesh." All the species are to be reckoned among the small fishes, the largest of them scarcely attaining a length of more than 1 dm. The Scandinavian species is one of the smallest.

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[a] *Cat. Brit. Mus., Fish.*, vol. III, p. 501.

[b] L. c., p. 492.

[c] According to Jordan and Gilbert 10 genera.

[d] This last character is given on the authority of Müller and Troschel, *Horæ Ichthyologicæ*, Heft. III. p. 20.

[e] *Hist. d. Poiss.*, pp. 106 and 177.

[f] Arch. per la Zoologia, L'Anatomia e la Fisiologia, Vol. III. Fasc. I. p. 177.

[g] *Eur. Mér.*, III. p. 278.

THE BIMACULATED SUCKER.

LEPADOGASTER BIMACULATUS.

Fig. 75.

Dorsal and anal fins distinctly separated from the caudal fin, the first containing at most 7 rays and the anal fin 6. Breadth of the snout just in front of the eyes greater than its length, which is about equal to the breadth of the interorbital space, to the length of the base of the dorsal or anal fin (the difference usually being only slight), or to the distance between the dorsal and caudal fins. Two nostrils on each side, within the line from the upper anterior corner of the eye, the posterior with a small muciferous pore beside it, the anterior alone with a slightly raised, tubular margin, but without any lobate appendage. Longitudinal diameter of the eye in small specimens (about 30 mm. long) $^2/_3$ *or more of the breadth of the interorbital space, in large specimens (over 50 mm. long)* $^1/_2$ *or less thereof. Longitudinal diameter of the entire adhesive disk about 18—21 % of the length of the body: pelvic disk (within the ventral fins) short and round: postclavicular disk trapezoidal, broadest behind. Length of the head from about* $^1/_4$ *to* $^1/_3$[a]*, greatest depth of the body from about* $^1/_9$ *to* $^1/_7$[b]*, least depth of the tail about* $^1/_{12}$[c]*, and the length of the caudal fin from about* $^1/_5$ *to* $^2/_{13}$[d]*, of the length of the body. Length of the pectoral fins about equal to the greatest depth of the body, the lateral flap of the posterior division of the ventral disk extending scarcely half-way up the pectoral fins.*

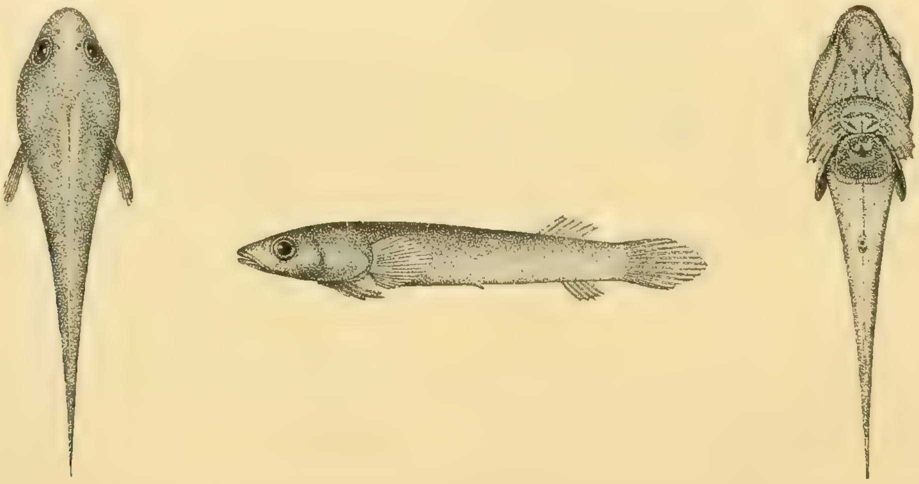

Fig. 75. *Lepadogaster bimaculatus* from Norway, M. v. DÜBEN 1845. Magn. 2 diam.

R. br. 6; *D.* 6[e]; *A.* 4[f]; *P.* 21 l. 22[g]; *V.* $\frac{(1)}{4}$; *C.* $x + 9$ l. $10 + x$; *Vert.* 29 l. 30.

Syn. *Bimaculated sucker*, PENN., *Brit. Zool.* (ed. 1776), tom. III, p. 345, tab. XXII, App.: *Cyclopterus bimaculatus*, DONOV., *Brit. Fish.*, IV, tab. LXXVIII; FLEM. (*Lepadogaster*), *Brit. Anim.*, p. 190; YARR., *Brit. Fish.*, ed. 2, vol. II, p. 363; DÜB. et KOREN, Vet.-Akad. Handl., 1844, p. 109, tab. III, fig. 7; NILSS., *Skand. Fn.*, *Fisk.*, p. 241; GTHR, *Cat. Brit. Mus.*, *Fish.*, vol. III, p. 514; COLL., Forh. Vid. Selsk. Christ., 1874, Tillægsh., p. 90; MOR., *Hist. Nat. Poiss. Fr.*, tom.

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[a] From 25·6 to 30·3 % of the length of the body, according to CANESTRINI. In specimens from Norway, of an average length of 30·7 mm., the length of the head is on an average 29·6 % of that of the body.

[b] From 11·6 to 15 % of the length of the body, according to CANESTRINI. In the Norwegian specimens just mentioned the average is 12·7 % of the length of the body.

[c] In the Norwegian specimens just mentioned the average is 8·1 % of the length of the body.

[d] From 20·4 to 15·5 % of the length of the body in specimens between 33 and 53 mm. long, according to CANESTRINI. In the Norwegian specimens just mentioned the average is 19 % of the length of the body.

[e] Sometimes, though seldom, 5 or 7, according to v. DÜBEN and KOREN.

[f] Sometimes, though seldom, 5 or 6, according to v. DÜBEN and KOREN.

[g] 23 or 24, according to v. DÜBEN and KOREN.

III, p. 361; DAY, *Fish. Gt. Brit. Irel.*, vol. I, p. 192, tab. LVII, fig. 3; LILLJ., *Sc., Norg. Fisk.*, vol. I, p. 739; COLL., N. Mag. Naturv., Bd. 29, p. 73.

Lepadogaster ocellatus + *Desfontainii* + *reticulatus* + *Mirbelii*, RISSO, *Ichth. Nice*, p. 74 et 77; *Eur. Mér.*, vol. III, p. 275 et 277; *Mirbelia Desfontainii*, CANESTR., Arch. Zool. Anat. Fisiol., vol. III, fasc. I, p. 192, tab. III, figs. 5 et 6.

Lepadogaster ocellatus + *maculatus* + *punctatus* + *lineatus*, GUICH., *Explor. Algér., Sc. Phys., Zool.*, V, pp. 109 et 110, tab. 6, figs. 3—5.

The length of the Bimaculated Sucker probably does not exceed about $5^1/_2$ or 6 cm. The largest specimen mentioned by CANESTRINI was 53 mm. long. DAY assumes that it attains a length of at least 2 in. (51 mm.); and MOREAU states that its maximum length is 60 mm. According to v. DÜBEN and KOREN its usual length on the coast of Norway is at most 37 mm. The specific name of this fish is derived from a very singular, but inconstant marking, and all the numerous synonyms given above are due chiefly to the variability of the coloration. "The ground-colour is always reddish", say v. DÜBEN and KOREN, "clear and bright, with a more or less pronounced dash of yellow, which forms small, irregularly arranged spots and dots or continuous bands, along the back and sides, or a row of large spots across the back etc. Straight across the forehead, between the eyes, we generally find a lighter streak, and behind the latter a darker-coloured belt extends across the body. On the sides, just behind the base of the pectoral fins, there generally, though not always, appears a round, black or dark purple spot, very distinctly and sharply marked and edged with a narrow, white stripe. The belly and the whole of the under surface are usually light yellow, with or without red spots or streaks on the lower jaw and the sides of the tail. The eyeballs are grayish olive-green at the top, with a brownish band in the middle, and below this somewhat lighter. The iris is golden-yellow, the pupil with beautiful shades of green and blue. The pectoral fins and the whole of the adhesive apparatus are always without spots, but the unpaired fins are mottled with yellow and red, more or less broken, transverse bands." MONTAGU[a] describes the colour of the fry as green, finely dotted with blue, and without the least trace of the two pectoral spots.

On the coast of Norway, at least at certain spots to the south-west, between Stavanger and Trondhjem, the Bimaculated Sucker can hardly be called rare, if not common. It occurs at a depth of 20 or 30 fathoms, especially where the bottom is soft and strewn with shells to which it may attach itself and its eggs. "On one occasion," write v. DÜBEN and KOREN, "five specimens were taken together, attached to the shell of a *Cyprina islandica.* On taking this little fish out of the water with the hand, it instantly attaches itself to the finger; even when thrown into alcohol, it sometimes adheres to the side of the vessel for a moment. Even in the water it is generally seen keeping quite still and adhering to some object, with the tail bent forwards, right up to the head[b]. The eyeballs are extraordinarily prominent[c] and may be turned, independently of each other (almost more than in the Flounders), in every direction; and when the fish is fixed to the bottom, it follows with its eyes, without the slightest turn of the head, every movement of any object, a pair of pincers for example, drawn through the water round about it. If the pincers come too near, the fish winces slightly, or moves in a gliding manner, without loosing its hold. If it is torn away by force, it makes all possible haste to re-attach itself to the first suitable object." There is only one instance recorded of its occurrence in Sweden. On this occasion a specimen $26^1/_2$ mm. long was taken by Dr. CARL AURIVILLIUS[d] in a dredge, among the Weather Islands (Väderöarne) off Fjellbacka, at a depth of about 40 fathoms, on the so-called Coral Bank, east of Storö. In Denmark it is unknown, but south of its true habitat, the Mediterranean, it has been found by STEINDACHNER[e] off Teneriffe.

According to RISSO the female is large with roe towards the end of May. On the 20th of July, on the coast of County Down (Ireland), HYNDMAN[f] took in a dredge, at a depth of 15 fathoms, a *Venus virginea,* in which he found a Bimaculated Sucker, together with the eggs and some specimens of the newly-hatched fry; and in August he dragged in Belfast Bay and found a single full-grown valve of *Pectunculus pilosus*, the hollow of which was close studded over, for the space of a square inch, with the eggs of this fish, the diameter of the eggs being about $^1/_{16}$ of an inch (1·6 mm.). LILLJEBORG also found the eggs of this species in empty mussel-shells on the coast of Norway, in the month of July.

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[a] Mem. Wern. Nat. Hist. Soc., vol. I, p. 92.

[b] The fishes of the preceding family have the same habit, as we have remarked above.

[c] "No words," says HUGHES, "can describe the singular beauty of its eyes. They are perfectly gemmeous, and appear like living opals set in burnished gold."

[d] According to LILLJEBORG, l. c.

[e] Stzber. Akad. Wiss. Wien, Math. Naturw. Cl., LVII, I (1868), p. 686.

[f] See THOMPSON, *Nat. Hist. Irel.*, vol. IV, p. 213.

HUGHES[a] observed this fish in an aquarium, and has recorded its variations of colour from yellowish white to a rich carnation hue, as well as its sluggishness and general inactivity. With regard to its food, he remarked that it ate small portions of mussel, oyster or raw fish. LILLJEBORG found in its stomach chiefly young specimens of shellfish (*Rissoæ*) and small crustaceans (*Copepoda* and *Ostracoda*).

CYTTOMORPHI.

Body deep and compressed, but comparatively short, oval, when seen from the side. Rays of the unpaired fins principally soft; anterior (spinous-rayed) part of the dorsal fin shorter (with fewer rays) than the posterior (soft-rayed). Ventral fins thoracic or jugular, well-developed, independent of each other and longer than the pectoral fins. No osseous connexion between the suborbital ring and the preoperculum. Anal papilla wanting. Scales small (sometimes wanting), sometimes scattered and imbedded in the skin, sometimes imbricated and furnished with small spines; at the edges of the body we sometimes find strong spinous plates.

The present series, like the following one, reminds us in a certain degree, by the weak development of the scales, of the series of the Mackerel type; and CUVIER[b] actually referred the John Dory, the best known type of this series, to the Mackerel family. GÜNTHER[c] was also impressed with this kinship between the Cyttomorphs and the Mackerels, but referred the former to a distinct family, *Cyttidæ*, by the side of the Horse-Mackerels. One abnormal form[d], which perhaps belongs to this series, renders the latter difficult to characterize; and though the kinship between these forms and the Mackerels is undeniable — though the grounds for this opinion are entirely different from those given by CUVIER — as we shall see more clearly in the following series, still, as we have followed GÜNTHER in his arrangement of the Vaagmaer-fishes as a separate series, in order to be consistent we must treat the Cyttomorphs in the same way, for their kinship with the Mackerels is apparently much less natural than the ties between them and the following series. The spinous plates of the Horse-Mackerels, both in position and in shape, are entirely different from those of the Cyttomorphs, whose anomalopterous characters also unfit them for a place in the Mackerel-series. The spinous plates of these fishes are more like those which occur in the Gurnards and Lump Sucker, and when they are wanting at spots where they may occur in other cases — e. g. at the base of the spinous-rayed (first) dorsal fin in the subgenus *Zeus* (s. str.) — they are replaced by lateral spinous processes at the base of each spinous ray, in which form they also appear in the genus *Trachypterus* within the following series. The typical Cyttomorphs are thus so closely and distinctly approximated to the forms of the following series, that their inclusion in the latter is a point which should rather be investigated. There too, we shall find the body compressed, the mouth highly protrusile, with the gape turned upwards when the mouth is closed, the maxillary bones broad and flat, the branches of the lower jaw broad and hanging down below the isthmus behind, the interoperculum large, the ventral fins long and furnished with numerous rays, and the pectoral fins short and with only few rays. As yet we know nothing, it is true, of the changes of development through which the Cyttomorph fishes pass during early youth[a], and which would probably give the safest clue to the solution of the question as to their right place in the system. But the points we have mentioned above, defend the position they occupy in the present work.

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[a] *The Zoologist* for 1864 (vol. XXII), p. 9131.

[b] "Les *Zées* ont deux dorsales et quelques autres caractères ostéologiques voisins de certains percoïdes; mais la nature de leurs tégumens, les boucliers dont les côtés sont armés, les rapprochent incontestablement des scombéroïdes à corps cuirassé:" CUV., VAL., *Hist. Nat. Poiss.*, vol. X, p. 2.

[c] *Introd. Stud. Fish.*, p. 450; *Handb. Ichthyol.*, p. 318.

[d] The obscure genus *Oreosoma*, CUV., VAL., *Hist. Nat. Poiss.*, vol. IV, p. 515, tab. 99.

The series, which derives its name from one of the genera, *Cyttus*, is composed of one, perhaps two[b], families, containing more or less pronounced deep-sea or pelagic fishes.

FAM. CYTTIDÆ.

No branched rays in the dorsal, anal or pectoral fins. The last-mentioned fins with few rays. Ventral fins with one spinous ray and more than five soft rays. Basal bones of the pectoral fins flat, but very narrow in the middle. Branched rays of the caudal fin few. Jaws and vomer furnished with comparatively weak, cardiform teeth. Mouth capable of extensive protrusion. Eyes lateral. Gill-openings large. Branchiostegal rays 7 or 8. Pseudobranchiæ present.

The family is not large, though its range extends over the basins both of the Atlantic and the Pacific. The 8 or 10 species it contains, may easily be included in two genera, *Zeus* and *Cyttus*, the latter without true (spinous) plates, with the spinous rays of the dorsal fin flexible at the tip, the fin being also without free, membranous appendages, and with only 2 spinous rays in the anal fin, but 8 branchiostegal rays.

GENUS ZEUS.

Scales small or wanting. Spinous plates, with one or two spines, along the whole or a part of the base of the dorsal fins, as well as of the ventral edge and the base of the anal fin. The two dorsal fins contiguous or coalescent, the anterior containing 9 or 10 strong, pungent spinous rays, and with the membrane between these rays elongated into long filaments or flat, clavate lobes. Anal fin with 3 or 4 strong spinous rays in front, which sometimes form a distinct lobe, representing an anterior anal fin. Branchiostegal rays 7. Air-bladder large and the pyloric appendages very numerous. Coloration with a more or less pronounced, silvery lustre, marked with black, either in the form of large, irregular, transverse or wavy, cloudy spots or of a sharply defined, round spot at the middle of the sides.

From this genus GILL[c], by the establishment of the genus *Zenoides*, has separated the species which have only three spinous rays in the anal fin, but are furnished with spinous plates even along the base of the spinous-rayed part of the dorsal fin, leaving the other species to form the true genus *Zeus*. All these species, however, are so nearly allied — only 5 or 6 can be distinguished with certainty — that it is impossible to recognise these divisions as more than subgenera. Only the latter division is represented in the Scandinavian fauna, and that by only one species.

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[a] As we know, L. AGASSIZ stated positively that *Argyropelecus hemigymnus*, a Mediterranean form of the family *Sternoptychidæ*, was a juvenile form of *Zeus faber* (Ann. Sc. Nat., ser. 5, vol. 3 (1865), p. 56), and LOW had already proposed (Proc. Zool. Soc. London 1843, p. 85) to range the genus *Sternoptyx* beside *Zeus*. The observation has not been confirmed, however, and KNER has justly remarked (Verh. Zool. Bot. Gesellsch. Wien, XV (1865), p. 288) its great improbability, though the resemblance to the *Sternoptychidæ* is worthy of mention.

[b] If the family *Oreosomatidæ* proves, on more minute investigation, really to belong to this series. In *Oreosoma*, according to CUV., VAL., the pectoral fins contain numerous branched rays, the palatine teeth are present and the ventral fins contain only 5 soft rays.

[c] Proc. Acad. Nat. Sc. Philad. 1862, p. 126.

THE JOHN DORY (SW. SJÖHANEN[a] OR SANKTEPERSFISKEN[b]).

ZEUS FABER.

Plate IX, fig. 2.

No plates along the base of the spinous-rayed part of the dorsal or the anal fin, the rays of these fins, on the other hand, being armed with a pointed spine, projecting outwards, on each side of the base. From 7[c] to 10 spinous plates of fairly uniform size along each side of the posterior part of the base of the dorsal fin, and from 7 to 9 along the corresponding part of the base of the anal fin. Both in front of and behind the jugular ventral fins is a row of plates on each side of the ventral edge and partly at its middle. The frontal spines, which project backwards on the occiput, as well as the supraclavicular and clavicular spines, simple and small, measuring less than half the longitudinal diameter of the eye and, in old specimens, more or less reduced, a rule which also applies to the symphysial, angular and articular spines of the lower jaw. Preoperculum, in adult specimens, without spines. Scales small and scattered, not imbricate, thin and smooth at the margin, but during youth spinous on the surface, the spines being most persistent on the scales belonging to the upper and lower parts of the sides, below the base of the soft-rayed dorsal and above that of the anal fin. Head scaly only on the cheeks. Coloration grayish violet, with a silvery lustre, marked with longitudinal yellow stripes on the sides of the body and with a round, blue-black spot, encircled by a narrow, yellow ring, about half-way up the sides and below the middle of the spinous-rayed dorsal fin.

R. br. 7; *D.* 10/23 l. 24; *A.* 4/22 l. 23; *P.* 13—15; *V.* $^{1}/_{7}$; *C.* 2+11+2 l. 1+13+1; *Vert.* 31—34.

Syn. *Zeus*, idem *faber* appellatus, PLINIUS, lib. IX, cap. 18.

Zeus spinosus, LIN., *Mus. Ad. Frid.*, I, p. 67, tab. XXXI, fig. 2.

Zeus faber, LIN., *Syst. Nat.*, ed. X, tom. I, p. 267; CUV., VAL., *Hist. Nat. Poiss.*, vol. X, p. 6; YARR., *Brit. Fish.*, ed. 2, vol. I, p. 183; GTHR, *Cat. Brit. Mus., Fish.*, vol. II, p. 393; COUCH, *Fish. Brit. Isl.*, vol. II, p. 118, tab. LXXIX; STEIND., Stzber. Akad. Wiss. Wien, Math. Naturw. Cl., LVII, I (1868), p. 364; COLL., Forh. Vid. Selsk. Christ. 1874, Tillægsh., p. 44; MALM, *Gbgs, Boh. Fn.*, p. 650; LTKN, Vid. Selsk. Skr. Kbhvn, ser. 5, Naturv. Math. Afd., vol. XII, No. 6, p. 553; GIGL., Espos. Int. Pesc. Berl. 1880, Sez. Ital., Cat., p. 86; MOR., *Hist. Nat. Poiss. Fr.*, tom. II, p. 467; DAY, *Fish. Gt. Brit., Irel.*, vol. I, p. 138, tab. XLVIII; OLSEN, *Piscator. Atl.*, tab. 34; LILLJ., *Sv., Norg. Fisk.*, vol. I, p. 285; COLL., N. Mag. Naturv., Christ., Bd. 29 (1884), p. 59.

Zeus australis, RICHARDS., *Zool. Ereb., Terr.*, II, 2, Fish., pp. 36 et 138, tab. XXV, fig. 1 (vide GTHR); TENN.-WOODS, *Fish., Fischer, N. S. Wales*, p. 61, tab. XXI.

? *Zeus japonicus*, SCHLEG., *Fn. Japon.*, p. 123.

The deep[d], compressed[e] body, with its spines at the margins[f] and the formidable weapons it also possesses in the first dorsal[g] and the anal fins[h], render the Dory easily recognisable, especially when the black, lateral spot is still to be found. Its recognition is also facilitated considerably by the long appendages of the fin-membrane of the first dorsal fin and the great length of the ventral fins[a]. On closer examination, however, the head[b] is the most striking point, for with the eyes set high and rather far back, though by no means small[c], it reminds us somewhat of that of a pig. It is most singular in appearance when the mouth is protruded. The nasal (frontal) processes of the intermaxillary bones are so long that their point, when they are drawn back, i. e. when the mouth is closed, extends up to the forehead between the eyes[d], where, on the top of the head, they slide in a groove extending along the whole length of the frontal bones, which is somewhat broader at the beginning and end, and the margins of which end in the above-mentioned spines, which really belong to the frontal bones, but are situated as though they were occipital spines. The great length of the nasal processes of the intermaxillary bones enables the fish to protrude the mouth so far that the snout, which is then extended in a lateral direction as well, becomes considerably larger than the rest of the head. The flat maxillary bones[e] then turn in their articulation, which is covered by the front part of the preorbital bone, and assume a vertically downward or forward position. By this action everything immediately in front of the fish is sucked into the mouth, and when the latter is again closed, the capture may be no small one. The lower jaw[f] always projects beyond the upper, but when the mouth is closed, the difference is less apparent.

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[a] LINNÆUS, *Mus. Ad. Frid.*

[b] MALM, *Gbgs, Boh. Fn.*

[c] Sometimes 6, according to LÜTKEN.

[d] In the 5 specimens which we have been enabled to examine, the length of the body (from the anterior margin of the upper jawbone, at the articulation, to the middle of the hind margin of the caudal fin) varies between 143 and 417 mm. In these specimens the greatest depth of the body varies between 44 and 48 % (44·5—47·7) of the length thereof. The least depth of the shallow peduncle of the tail (in front of the caudal fin) varies between 6 and 7 % (6·4—7·1) of the length of the body.

[e] In the specimens mentioned above the greatest thickness (breadth) of the body, which occurs across the preoperculum, varies between 7 and 10 % (7·6—9·8) of the length of the body. The proportion generally increases with age. The least breadth of the interorbital space is always less than the least depth of the tail, varying in different individuals between about 5 and $5^{1}/_{2}$ % (5·2—5·7) of the length of the body, or 60 and 68 % of the longitudinal diameter of the eye.

[f] The plates at the base of the soft-rayed dorsal and the anal fins are each furnished with two spines, the inner spine (along the dorsal fin the lower and along the anal fin the upper) being directed straight out from the body, and the outer spine, which is the larger, pointing backwards. The first anal plate, in the second and third specimens in point of age, is situated beside the fourth spinous ray, which in these cases is without a special basal spine; while in the younger specimens, as well as in the oldest of all, this plate is situated beside the first soft ray, and the fourth spinous ray is furnished with the usual, simple basal spine on each side. The plates at the side of the ventral margin in front of the base of the anal fin vary in number between 7 and 10 (anteriorly single, posteriorly paired), in front of the ventral fins, and between 7 and 9, behind the latter. In all these plates the short, but sharp spine is directed backwards. Just in front of the ventral fins and, in one specimen, in front of the vent a simple row of spines is inserted at the middle of the ventral margin. In the smallest specimen the head is furnished with two blunt spines, one above and one below, in the anterior orbital margin and a third at the upper posterior corner of the orbit; but in older specimens these spines become indistinct. According to KNER (l. c.), the preoperculum in young specimens (55 mm. long) is furnished with a marginal spine. This spine does not occur, however, in any of our specimens.

[g] The third spinous ray is the longest — though in the least but one of our specimens it is scarcely any longer than the second — being about equal in length to the lower jaw, i. e. about half the greatest depth of the body. In the oldest specimen, however, this ray is broken off short, but its relative length has evidently been considerably less than in the younger specimens, for the free dermal flap behind it is preserved, but is only equal in length to the lower jaw.

[h] In the anal fin the first spinous ray is sometimes the longest, and sometimes the second, but the length in proportion to that of the body decreases with increasing age, in the younger specimens being about $^{1}/_{6}$ of the length of the body, measured as above, in the older specimens $^{1}/_{7}$, $^{1}/_{8}$ and finally $^{1}/_{10}$ thereof.

The two nostrils on each side are set close to the anterior orbital margin, being mutually separated only by a narrow dermal wall. The anterior is the smaller and almost round, the posterior being oblong and perpendicular.

The base of the spinous-rayed dorsal fin is about equal in length to that of the soft-rayed, which, on the other hand, is somewhat longer and higher than the soft anal fin, to which it is analogous in other respects. Both the latter fins are rounded at the margin and have the longest rays in the posterior half, the longest ray in the soft dorsal fin being about half as long as the caudal fin. The margin of the caudal fin is also slightly rounded (convex), the outer branched rays being, however, slightly longer than the middle ones. Its relative length[g] diminishes with increasing age. The pectoral fins are small[h] and rounded, with few rays, and situated below the middle of the sides and behind the perpendicular from the insertion of the ventral fins. Their length in young specimens is more than half that of the lower jaw, but in older ones equal to or, eventually, less than this measurement.

The lateral line forms a sloping curve from the temporal region to the middle of the side, just in front of the perpendicular from the middle of the base of the soft-rayed dorsal fin, from which point it runs in a straight line to the middle of the base of the caudal fin.

The Dory attains a length of about 5 dm., according to COUCH, 6 dm., according to MOREAU. Its maximum weight on the English coast, according to the former writer, is about 8 kgrm. As we may easily see by the shape of the fish, it can scarcely be regarded as possessing any great power of swimming. The deep body may indeed be steered and maintained in an upright position by the help of the long ventral fins and the high, spinous-rayed dorsal fin with its long, dermal appendages. Still, when it swims upon its prey, it does so by fits and starts, or approaches with extreme caution and very slowly. In its usual position, too, it lies upon its side, whether swimming through the water or resting on a rock[a].

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[a] The relative length of the ventral fins decreases during growth from 38 % of the length of the body, in the youngest of our specimens, to $20^1/_2$, in the oldest specimen.

[b] The relative length of the head, measured from the anterior margin of the articulation of the maxillary bones to the end of the opercular flap, apparently undergoes but slight change of growth, varying in our specimens between 29 and 31 % (29·1—30·9) of the length of the body.

[c] The longitudinal diameter of the eye varies with age, in our specimens, between 9 and about 8 % (9·1—8·2) of the length of the body or 30 and 27 % (30·5—27·3) of the length of the head.

[d] The distance from the middle of the anterior margin of the intermaxillary bones to the tip of their nasal processes is about equal to (sometimes somewhat less than) the length of the maxillary bones or of the interoperculum, equal to the distance from the anterior margin of the preorbital bone to the hind margin of the preoperculum, twice the longitudinal diameter of the orbit, or half the depth of the body at the beginning of the soft-rayed dorsal fin; but in young specimens somewhat less than the last measurement.

[e] The length of the maxillary bones varies in different individuals between about 19 and $20^1/_2$ % (19·1—20·4) of the length of the body. They are flat even above the articulation and the upper (anterior) end is as broad as the lower, but at the articulation they are narrowed.

[f] The length of the lower jaw, including the angular spine, varies between 23 and 25 % (23·0—24·7) of the length of the body.

[g] In the smallest four of our specimens the length of the middle rays of the caudal fin varies between about 24 and 22 % of that of the body. In the largest specimen the caudal fin is damaged, but its length seems to have been scarcely more than 16 % of that of the body.

[h] The relative length of the pectoral fins also decreases during growth, in our specimens, from about 13 to 11 % (13·2—11·2) of the length of the body.

Its usual manner of gliding through the water is also accomplished by continuous undulating movements of the soft-rayed dorsal fin, the corresponding part of the anal fin, and the pectoral fins, the other fins remaining motionless[b]. Nevertheless, the Dory is said to make long journeys from deep water to the shallows. It is fond of a rough bottom, says Couch, or digs a hole in the sand, where it hides, like the Angler, with the long filaments of the spinous-rayed dorsal fin waving like worms to entice its prey, which consists of Flounders, Herrings, other fishes and small fry, cuttle-fish and other mollusks, and crustaceans[c]. It is said to make a grunting noise when drawn out of the water. It generally leads a solitary life, being only seldom taken in large numbers, but it is known and prized as a dainty dish. The flavour of the flesh is compared to that of a lobster's claw[d] or of the Turbot, or set even higher than the latter. It is said to be best in early spring, from January to March[e], especially when it has been kept a day or two, or rinsed in fresh water, after it has been gutted. Its qualities, however, are not all good: Day states that its spines are capable of inflicting dangerous wounds. The spawning-season is said to occur during the winter months[f]. Olsen states the number of eggs in a female specimen at 3,000.

The singular name (*Sanktepersfisk*, St. Peter's Fish) is derived from a tale to the effect that it was this fish that St. Peter caught in the Lake of Gennesaret, and out of whose mouth he took the tribute money. According to another version of the story, the apostle caught the fish, but when he heard the grunting sound, interpreted it as a cry of complaint, and released his captive. The bluish-black spot on each side of the body is thus the mark left by Peter's grasp[g]. The Dory, however, does not occur in any lake. It is a true salt-water fish, in European waters being most common perhaps in the Mediterranean and the Atlantic outside it. On the south and west coasts of Great Britain, however, it is still fairly common. In the North Sea it becomes rarer and rarer towards the North, and its true geographical range probably does not extend further north than the Dogger Bank, though it is taken once or twice a year on the Scotch coast. It has been met with twice on the coast of Norway, once at Glesvär, in the neighbourhood of Bergen, and again at the very head of Christiania Fjord. It has only once been found in Sweden. On the 5th of August, 1887, a female with very small eggs in the ovaries and with the caudal fin somewhat damaged, thus rendering the length, which was probably 435 mm. from the point of the lower jaw to the end of the middle rays of the caudal fin, impossible to fix with certainty, was caught off Stockevik in Skaftöland (Bohuslän). In the Scandinavian waters this species is thus one of the rarest. By the rest of its geographical extension, however, it seems to be a cosmopolitan species, for there is only an extremely slight difference between this species and *Zeus capensis* of the Cape of Good Hope. The latter may perhaps deserve a distinct specific name as the form marked by an increase in the number of the spinous plates, while *Zeus pungio*, the species which occurs in the Mediterranean, can ground its claim to the rank of a distinct species only on the more advanced development of some of these plates than of others. The difference is still less, however, between the present species, *Zeus japonicus* and the Australian *Zeus australis*, the last of which Günther, who had examined the original specimen described by Richardson, unhesitatingly referred to the same species as *Zeus faber*.

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[a] Though this habit of lying on its side has not left such distinct traces in the structure of the Dory as the similar, but more pronounced habit in the Flounders, still it has not been entirely without effect, for we find a want of symmetry even in this species. The spinous plates at the bases of the soft-rayed dorsal fin and the anal fin are set farther forward on one side of the body than on the other, and their number, too, is often different on either side. This is more often the case in old specimens than in young.

[b] Saville-Kent, *Nature*, July 31, 1873.

[c] In the stomach of a Dory about 32 cm. long Couch found 25 Flounders, some of which were 6 cm. in length, 3 half-grown Father-Lashers and 5 pebbles from the beach, one of which was 4 cm. long. Another Dory not quite half a kilogramme in weight, had 18 Sprats, 2 Atherines, a cuttle-fish and some digested fragments of other species in its stomach. The Dory thus does not seem to be at a loss how to procure food.

[d] Olsen, l. c.

[e] Blanchère, *Nouv. Dict. Gén. Pêches*, p. 246. Olsen states, on the other hand, that the Dory is best from May to January.

[f] Day, l. c. and Olsen, l. c.

[g] The same tale is also told of the Haddock.

TRACHYPTEROMORPHI.

Body ribbon-shaped[a], silvery and scaleless. Dorsal fin long (extending along by far the greater part of the dorsal edge), in front high or crest-shaped and sometimes separated into an anterior dorsal fin, which is deciduous and usually wanting in old specimens. Anal fin small or wanting. Pectoral fins usually small, with few rays and horizontal base. Ventral fins during youth long and furnished with numerous rays, but entirely or (usually) partly disappearing with age[b]. Branches of the lower jaw high and triangular.

With the exception of the *Cepolæ*, which are now referred to the Blennomorphs, CUVIER'S *Tænioïdes*, as he eventually defined this family[c], corresponds to the Trachypteromorph series, which in GÜNTHER is represented by the two series *Lophotiformes* and *Tæniiformes*[d].

In many respects the Trachypteromorph series comes nearest the Mackerel series: the elongated, ribbon-shaped body, with the long dorsal fin, most nearly resembles that of the *Trichiuridæ*, but also reminds us of the Dolphin-fishes (*Coryphæna*), the nakedness of the body too, reminds us most of the former, but also suggests the scaleless Horse Mackerels (*Gallichthys*), while its silvery, deciduous epidermis is a reminiscence of the Sea-Breams (*Bramidæ*). The horizontal base of the pectoral fins — which also occurs in the *Trichiuridæ* — and the high, triangular branches of the lower jaw call to mind the Opah (*Lampris*). The history of development, which is always the safest guide to the determination of kinship, also seems to point in this direction, for what we now know, thanks to EMERY'S valuable observations, of the development of the Trachypteroids, directs our special attention to the extraordinary reduction in the original length of the fin-rays, a point which had already been shown in the species of the genus *Gallichthys*, starting from the Blepharoid stage, and, on a smaller scale, in *Selene*, another genus of the same family. The round, black, lateral spots, which are so characteristic of the true Trachypteroids, as well as of the Dory, are also represented, strangely enough, by the evanescent spots in the fry of *Gallichthys*. These changes of development thus seem to indicate a starting-point common to the Scombromorph and Trachypteromorph series; but from this starting point their development has advanced in directions so widely different that we may well be justified in following GÜNTHER, and treating the latter series as independent. Anomalopterous characters, as we have already remarked, belong, as a rule, to the lower (earlier) stages of development, and in the Trachypteromorphs these characters have been retained in conjunction with a most extraordinary shape of the body.

The series contains two families, the one, *Lophotidæ*, with only one genus, remarkable for the restriction of its occurrence, to the best of our knowledge, to the Mediterranean Sea and the Japanese part of the Pacific (see above, p. 69), and distinguished by the small size of the anal fin behind the vent, which is situated close to the end of the tail, as well as by the slight degree of protrusion of which the mouth is capable. The second family contains the true Dealfishes and the Oar-fishes (Kings-of-the-Herrings).

FAM. TRACHYPTERIDÆ.

Mouth capable of extensive protrusion. No anal fin. Vent situated at the middle of the ribbon-shaped body. No air-bladder. Pseudobranchiæ and pyloric appendages well-developed. No branched or articulated fin rays[e].

This family consists entirely of true deep-sea fishes, and our knowledge of its adult state is derived exclusively from the solitary specimens which now and then approach the surface for some reason or other, and are more or less helplessly driven ashore by wind and tide. We have already quoted from Günther some of the most important, general characteristics which belong to the deep-sea fishes. One of these characteristics, the loose structure of the body, both in the osseous and muscular texture, appears in a high degree in the Trachypteroid family. The larger forms at least — some of the Trachypteroids attain a length of at least 6 metres — are so fragile that even with the greatest caution it is scarcely possible to draw a specimen out of the water without damaging some part of it. Still less can we expect that a specimen cast ashore by the storm and exposed to the action of the waves, may be found in a perfect condition. Furthermore, the fins and their appendages undergo changes of growth so great that it is by no means always possible to decide with certainty whether the loss of a character derived from these parts of the body is the result of some injury or merely of the natural development. The specific distinction within this family is, therefore, far from certain, and the majority of the species established by former writers up to the time of Valenciennes[a] and recognised even in Günther's *Catalogue*, have been rejected or proposed for rejection in more recent times. The history of the development has shown a variability scarcely conceivable before, in the supposed specific characters. The pioneer of this reform is the Italian Emery[b], who enjoyed the most favourable opportunities of studying the young of these fishes, as they appear in the surface-regions of the Mediterranean.

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[a] This is the case in the museum-specimens preserved in spirits; but we know that, in these fishes, as in other true deep-sea forms, the body is of extremely loose structure, and shrinks considerably after death, while during life it is probably more terete. The fishermen of Finmark stated to LILLJEBORG in 1848 that the Dealfish he received from them, was "about 6 in. thick somewhat behind the head" just after its capture, i. e. at this spot the thickness was more than half the depth.

[b] In *Lophotes*, however, the ventral fins are described as small, with the ordinary number of rays.

[c] CUV., VAL., *Hist. Nat. Poiss.*, vol. X, p. 309.

[d] *Acanthopterygii* §§ III and IV, *Syst. Syn.*, *Cat. Brit. Mus.*, *Fish.*; *Introd. Stud. Fish.*, pp. 519 and 520; *Handb. Ichth.*, pp. 369 and 370.

[e] According to KNER (Stzber. Akad. Wiss., Wien, Math. Naturw. Cl., XXXIV, I (1859), p. 437, tab. 1), however, *Trachypterus altivelis*, a Pacific species, is furnished with branched rays in the caudal fin. According to COSTA (*Fn. Regn. Nap.*, Pesci, Acant. Scomberoidei,

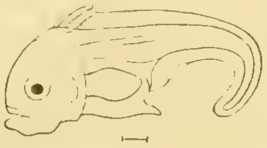

Fig. 76. Young *Trachypterus*. 3 mm. in length. After Emery.

The first stage in the development of a *Trachypterus* described to us by Emery (fig. 76), is a larva 3 mm. in length. At this period it is perhaps most like the larva of a *Cottus* or a *Lophius*. The head is large, and the long caudal part sharply contrasted to the much deeper abdominal region. The whole body is transparent. The embryonic vertical fin runs without a break along the margin of the body, from the head along the back and round the tail to the end of the abdominal part. At the occiput this fin contains the rudiments of three true rays, with this exception it is without rays, and is supported only by the primary rods (fibrillæ). The pectoral fins are comparatively large, with a brachiate base, and edged with a rim of the same structure as the vertical fin. The rudiments of the ventral fins appear in the form of a process on each side, projecting backwards from the lower posterior corner of the abdominal part.

In the next stage described by Emery (fig. 77), the larva has attained a length of 6 mm. It is now tadpole-like, and the first three rays of the dorsal fin have grown beyond the fin-membrane, thus reminding us of the Batrachoids. Behind them three new rays have begun to appear, and the embryonic vertical fin has grown to such a height on the caudal part that the hind part of the larva is nearly as deep as the forepart. The rudiments of the pectoral and ventral fins have also grown. The whole larva is still transparent, but finely punctated with small, brown collections of pigment, forming two transverse bands on the caudal part.

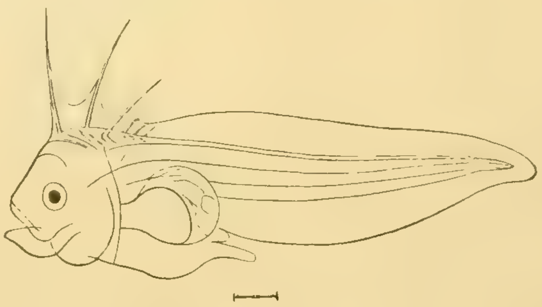

Fig. 77. Young specimen of *Trachypterus*. 6 mm. in length. After Emery.

In a larva 9 mm. long, which was brought home by Professor Leche from Messina, the caudal part of the body itself is still terete and of an elongated, conical shape. The occiput is raised as in *Lophotes*. The dorsal fin has begun to acquire rudimentary rays throughout the greater part of its length from the occiput. The anterior dorsal rays have attained a length

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Gen. Trachypterus, p. 14, tav. IX ter), the first ventral ray in *Trachypterus repandus* (*iris?*), a Mediterranean form, is divided at the tip into four membranous filaments (see fig. 81, *a*). With these exceptions little is known of the structure of the ventral rays in the older specimens, as they easily and generally break or drop off. During youth, however, and even in specimens 32 cm. long, they are unbranched in the specimens we have examined of the Mediterranean species *Trachypterus iris*.

[a] Cuv., Val., *Hist. Nat. Poiss.*, vol. X, pp. 313 etc.

[b] Atti Accad. Linc., ser. 3, Mem. Sc. Fis., vol. III, p. 390, con tav.: Mitth. Zool. Stat. Neap., Bd. I (1879), p. 581, tab. XVIII.

equal to that of the body. The abdominal part of the body *plus* the head is about equal in length to the caudal part, but the base of the ventral fins still remains just behind and below that of the pectoral. Four of the rays in each ventral fin are already elongated. The caudal fin has begun to form the first rudiments of its true rays below the end of the notochord, which is curved upwards at the tip, though as yet only slightly. Externally, however, the tip of the tail is still symmetrical, with a lobate extension of the embryonic vertical fin which is about equally large above and below the end of the notochord; but only the lower lobe is furnished with rudimentary rays, while in the upper we find only the primary fibrillæ, which are destined soon to disappear, together with the whole of this lobe. Chromatophores are scattered both on the raised occiput and the sides of the abdominal cavity.

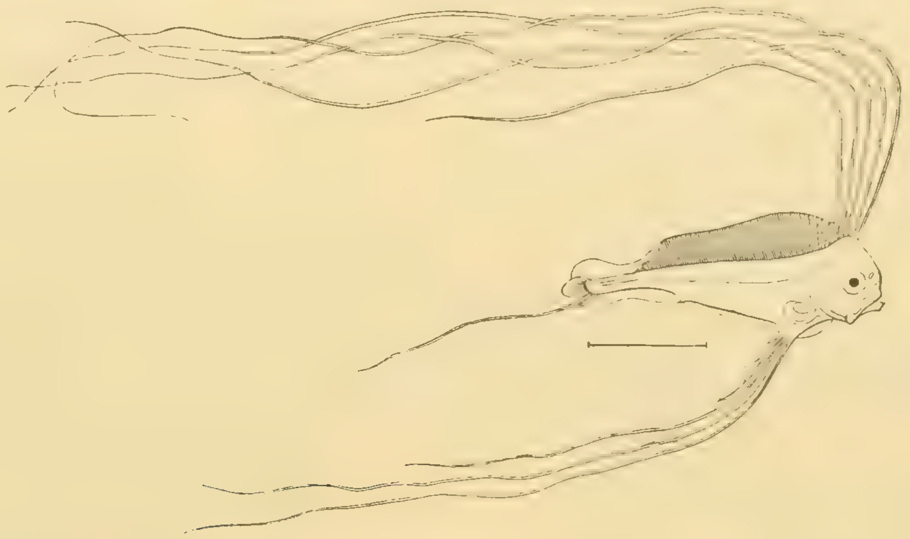

Fig. 78. Young specimen of *Trachypterus iris*, 16 mm. in length. After EMERY.

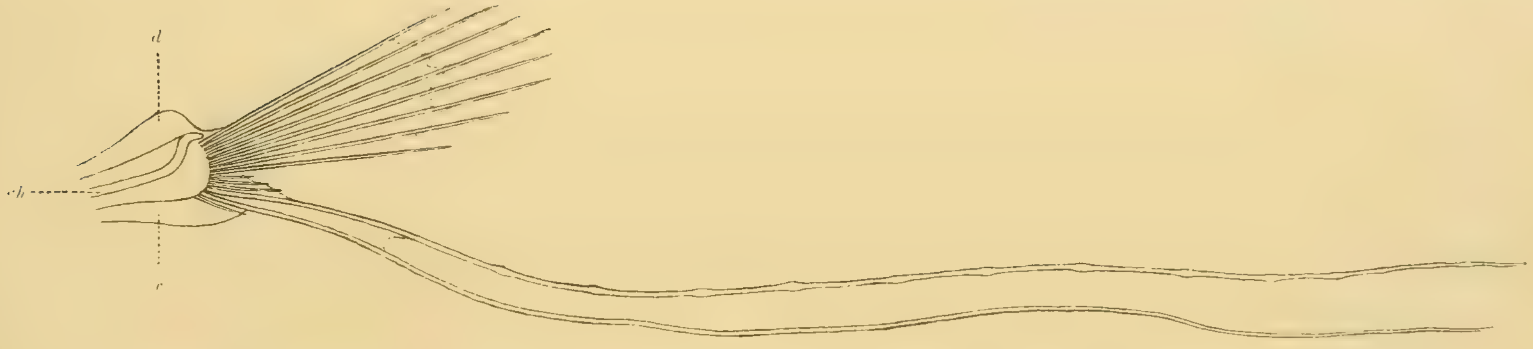

Fig. 79. Caudal fin of a *Trachypterus iris* 26 mm. long, from Messina. *d*, embryonic vertical fin of the back; *v*, embryonic vertical fin of the ventral edge; *ch*, chorda dorsalis.

In the next stage of the development described by EMERY (fig. 78), the larva has attained a length of 16 mm. The silvery colour has now begun to deposit itself on the skin. In other respects the larva is only slightly changed from the appearance it had at a length of 9 mm.; but the development of the embryonic pectoral fins is now arrested, their brachiate base showing signs of reduction. The five occipital rays of the dorsal fin and the three outer ventral rays have attained a length more than double that of the body, but are united to a fairly great extent at the base by the fin-membrane. The three inner rays of the ventral fins gradually diminish in length. The vent lies at the end of the second third of the length of the body. The embryonic vertical fin is still present along the ventral margin, but there are no rudiments of true rays in front of the caudal fin, and there seems to be no rudiment of a true anal fin. The caudal fin, on the other hand, has passed through a great part of its early alterations.

This fin originates, here as in all Teleosts, at the ventral part of the caudal end of the embryonic (larval) vertical fin, but in front of the end of the notochord. It thus belongs originally to the same division as the anal fin, and in the larvæ of many Teleosts its original position is so far forward that in this respect it is fully analogous to an anal fin. In *Trachypterus*, where no distinct anal fin is developed, it has been proposed, indeed, to regard a part of the caudal fin as representing the remainder of the anal fin. But there is scarcely any ground for this hypothesis, as in specimens 9 mm. long the primary caudal fin is still perfectly normal in structure, and only after this stage, though still at an early period, begins to undergo a considerable change, in conjunction with a reduction of its lower (originally anterior) part. When the notochord acquires its usual upward curve (fig. 79) — here in a double, S-shaped bend — the upper (originally the posterior) part of the caudal fin grows out in the form of a distinct division, consisting of 8 rays united by the fin-membrane throughout the greater portion of their length. In the lower part, on the other hand, which consists of 6 rays, the two rays next to the lowest, which for the rest of the larval period become considerably elongated, to about the same length as that of the body, are united only for a small part of their length by the fin-membrane, while the other rays in the lower part remain short, scarcely projecting beyond the fin-membrane, the upper (innermost) three resembling ordinary caudal rays, but the lowest (outermost) ray with the appearance rather of a supporting ray. This last ray subsequently bends straight downwards and is changed into the double spine which, in the adult specimens, lies below the two last plates of the lateral line. The lateral line, with its upright spines — one at the middle of each plate on the hind part of the tail in the older larvæ[a] — ends at the middle of the base of the lower division of the caudal fin, i. e. at the space between the upper of the two elongated rays and the lowest of the small, middle rays of the caudal fin.

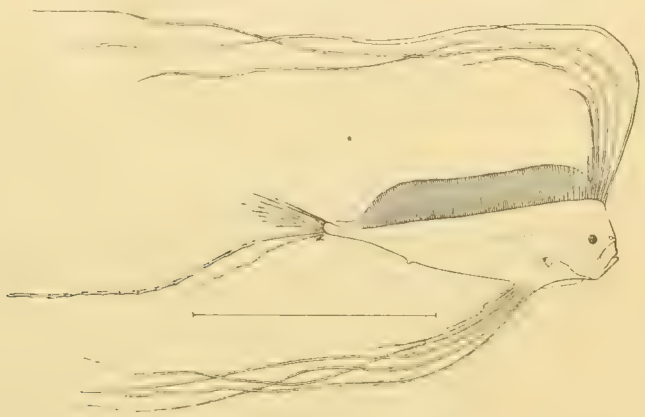

Fig. 80. Young *Trachypterus iris*, 32 mm. in length. After EMERY.

When the larva has attained a length of 32 mm. (fig. 80), the caudal fin has reached the highest point of its development, but still retains the position common in the Teleosts, in relation to the longitudinal axis of the body. The elongated rays of the dorsal, ventral and caudal fins are adorned with chromatophores, and most of these rays are furnished with lobate appendages[b], the remnants of the fin-membrane, arranged in pairs at certain intervals (fig. 81, *a*). The embryonic pectoral fins are still further reduced, but true rays have now begun to form in the membrane. The number of rays in the ventral fins has increased to 8, and the rays in the dorsal fin extend back almost to the caudal fin. Along the sides of the dorsal and caudal rays and of the first ventral ray, the rudiments now begin to appear of the small spines from which the genus *Trachypterus*[c] derives its name; but even these formations probably disappear, as a rule, at a greater age, although they have also been employed as a specific character.

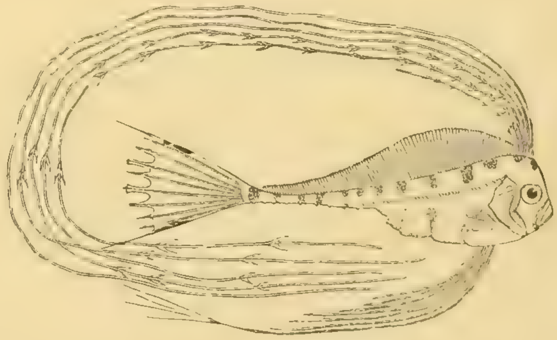

Fig. 81, *a*. Young *Trachypterus repandus* (*iris?*). $^{1}/_{3}$ of the natural size. After COSTA (copied in GÜNTHER).

The spinous plates on the lateral line and the basal spines of the rays of the dorsal fin are still wanting; but with these exceptions the *Trachypterus*-type is perfect, and the fish may continue to preserve this form

[a] With age the plates on the anterior part of the lateral line also develop similar spines.

[b] These appendages, as shown in the figure given by COSTA and copied in GÜNTHER (*Introd. Stud. Fish.*, p. 521), are probably nothing more than remnants of the fin-membrane, torn loose as the rays detach themselves from the latter. But they are perhaps highly important in a biological respect to the larvæ. While the length of the rays assists the larva, which is without doubt a poor swimmer, to support itself in the water, these processes perhaps serve to protect it by the resemblance it thus acquires to the Stinging Medusæ (*Siphonophoræ*). In figure 81, *b*, from a somewhat older ($^{1}/_{3}$ longer) specimen of *Trachypterus iris* from Messina, these appendages are lost, while the number of rays is simultaneously reduced, both in the anterior dorsal and the ventral fins.

[c] "With rough fins."

at least until it is 100 mm. long (excluding the caudal fin), without any reduction of the long, anterior rays of the dorsal or the ventral fin (fig. 81, *a*). Sometimes, however, this reduction appears at an earlier period, the elongated, lower rays of the caudal fin also shrinking and vanishing, while the upper division of the caudal fin, which eventually assumes the appearance of a perfect fin, with the two outermost rays strongest and longest, takes up a vertical position on the dorsal edge of the end of the tail, in the form of an upright fan (fig. 82).

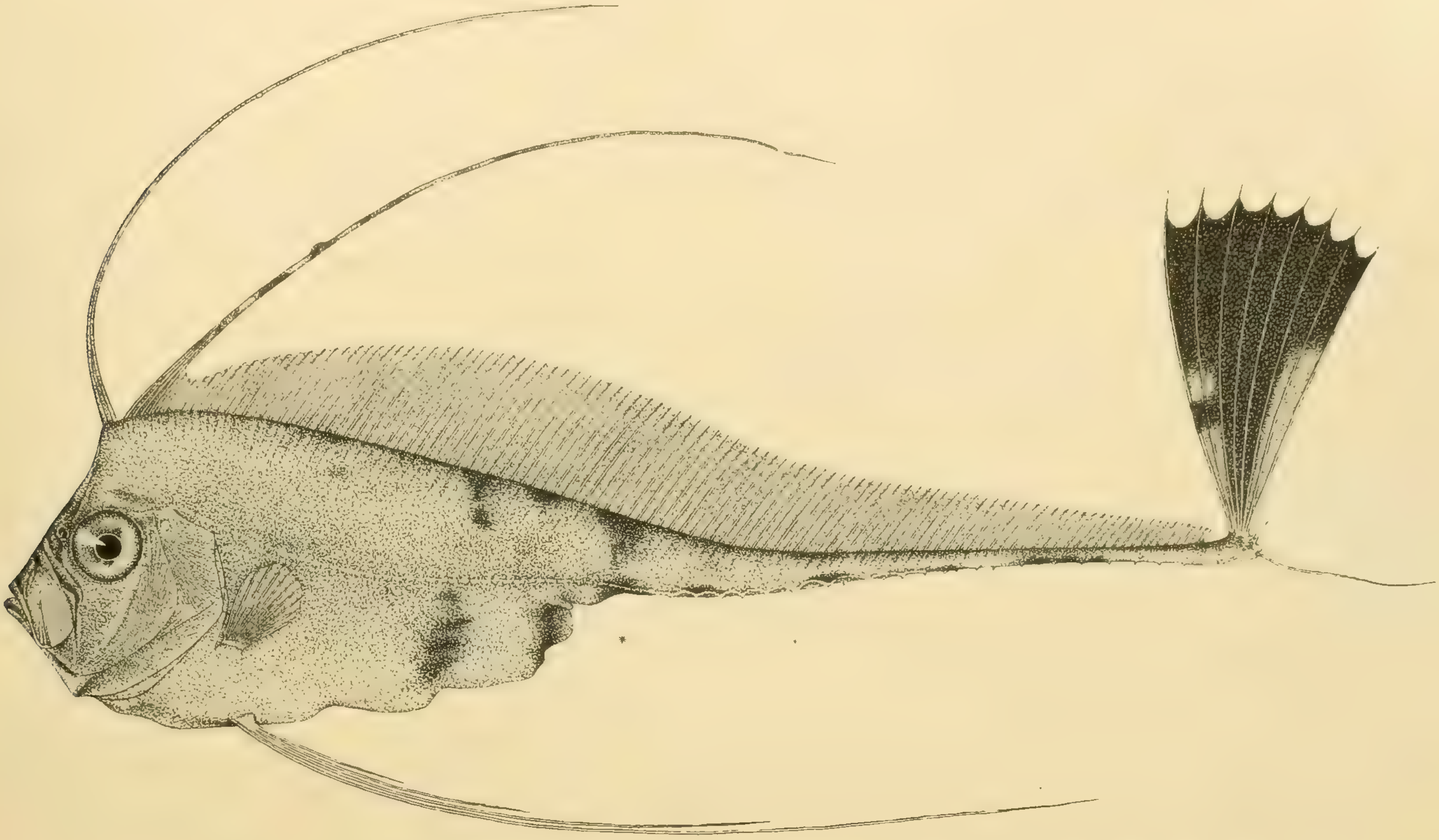

Fig. 81 *b*. Young *Trachypterus iris* from Messina, brought home in 1891 by Dr. Bovallius. Nat. size.

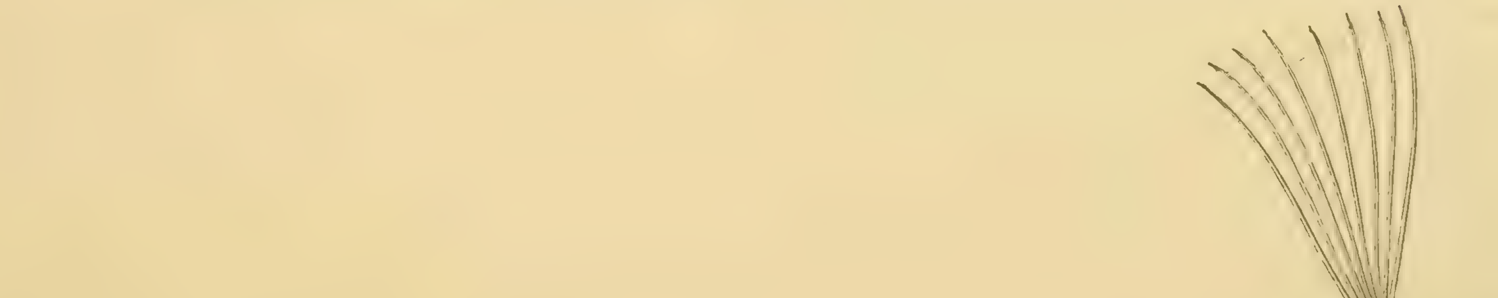

Fig. 82. Caudal fin of a *Trachypterus iris* 42 mm. long, from Messina. Magnified.

In the course of development, however, a great dissimilarity may prevail: the same stage of development is attained earlier (at a smaller size) by one larva and later by another; and we are still far from competent to decide with certainty whether this dissimilarity depends on a difference of species. We know, however, that, at a more advanced age, great individual variations appear in the characters of the best-known species. Emery has shown that, in the Mediterranean *Trachypterus iris*, the length of the head, during the growth of the body from a length of 95 to 1,410 mm., relatively sinks from 23 to $9^1/_2$ % of the length of the body and the greatest depth of the body from $28^1/_2$ to $10^1/_2$ % of the length, while the length of the tail (the distance between the vent and the caudal fin) undergoes even relative increase from $31^1/_2$ to 60 % of that of the body — changes which are extremely extraordinary and significant in fishes that, in spite of them, have attained the typical form of their species. At the same time his measurements show individual deviations from these rules so marked that none of the above relations can be employed as a specific character. The number of rays in the dorsal fin of this species is just as irregular, varying individually in full-grown specimens between 130 and 179, excluding the 5 or 6 rays, the number of which is also inconstant, in the anterior division of the fin.

Such is our knowledge of the whole of this family, the natural history of which has hitherto been drawn from specimens usually rare and more or less damaged, of species which are evidently subject to great changes of development and irregular variations, even in their adult form. The family has been divided, however, into three genera[a], two of which occur within the limits of the Scandinavian fauna, the one furnished with teeth in the jaws and on the vomer, the other probably without any teeth in the mouth, at least in adult specimens.

Genus TRACHYPTERUS.

The silvery body smooth and even on the sides, but with spines on the lateral line and at the base of the dorsal rays. Upper part of the caudal fin erected into a fan, more or less perpendicular to the longitudinal axis of the body, while the lower part of the fin is stunted. Recurved, pointed teeth scattered on the inner surface of the intermaxillary bones, in the front part of the lower jaw and on the head of the vomer. Number of rays in the dorsal fin less than 200. Branchiostegal rays 6. Bottom of the stomach short.

The genus of the *Vogmar*[b] or *Sölv-qveite*[c] was known to the ancient writers, who called it *Tænia*[d]. Neither Artedi nor Linnæus knew it by autopsy; and Gouan[e] was the first to introduce it into the system of modern times, under the name of *Trachypterus*. Immediately afterwards the Icelandic Dealfish was discovered, and in Olafsen's *Voyage* referred to Artedi's genus *Lepturus*[f], while Brünnich subsequently proposed to refer this species to the Gronovian genus *Gymnogaster*[g], the name under which this genus was first claimed for the Scandinavian fauna by Nilsson.

We have already remarked the difficulty of defining the species in this genus. Even in Giglioli's list of the forms belonging to the Italian fauna[h] there appear seven species from the Mediterranean. We should further recognise one distinct species from Madeira, one[i] from the North of the Atlantic and two[j] from the Pacific Ocean. The number of species has been so reduced, however, by Emery (l. c.) and still further by Lütken[k], that we can now scarcely recognise more than two species as belonging to the basin of the Atlantic, the northern species, though it attains a greater length, merely representing the earlier (lower) stages in the same course of development as that of the southern.

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[a] Of one of these genera, *Stylophorus*, only one specimen is known, which was taken at the beginning of this century between Cuba and Martinique, and is now in the possession of the British Museum. This genus is characterized chiefly by the persistency in this specimen (28 cm. long) of the long caudal ray, twice the length of the body, which we have remarked in the larva of *Trachypterus*.

[b] *Vogmere* or *Vogmær* = maid of the bay (from *vog*, bay and *mær*, maid), according to Olafsen, *Reise igjennem Island* (1772), p. 594.

[c] This is the name given to the Scandinavian species in the north of Norway. See Lilljeborg, Vet.-Akad. Handl. 1850. The name signifies Silvery Halibut.

[d] *ταινία*, Aristot., *tænia*, Rondel.

[e] *Hist. Pisc.* (1770), pp. 104 and 153, *Trachipterus* (*sic*).

[f] Art., *Descr. Spec.*, p. 111.

[g] *Zoophyl.*, fasc. I, p. 136.

[h] Espos. Intern. Pesca, Berlino 1880, *Cat. Sez. Ital.*, p. 91.

[i] Two, according to Nilsson.

[j] The American *Trachypterus altivelis*, Kner, l. c., and the Australian *Trachypterus* (*Regalæcus*) *jacksoniensis*, Ramsay, Proc. Lin. Soc. N. S. Wales, vol. V, p. 631, pl. 20.

[k] Vid. Meddel. Naturh. For., Kbhvn 1881, p. 190.

THE DEALFISH OR VAAGMAER (SW. VOGMAREN: NORW. SÖLVQVEITEN).

TRACHYPTERUS ARCTICUS.

Fig. 83.

The greatest depth of the body, which is deepest at a point nearer the vent than the head or even at the vent itself, undergoes even relative increase with age in specimens more than 1 metre in length, and is more than 15 % (on average about 17 %) of the length of the body, excluding the caudal fin.

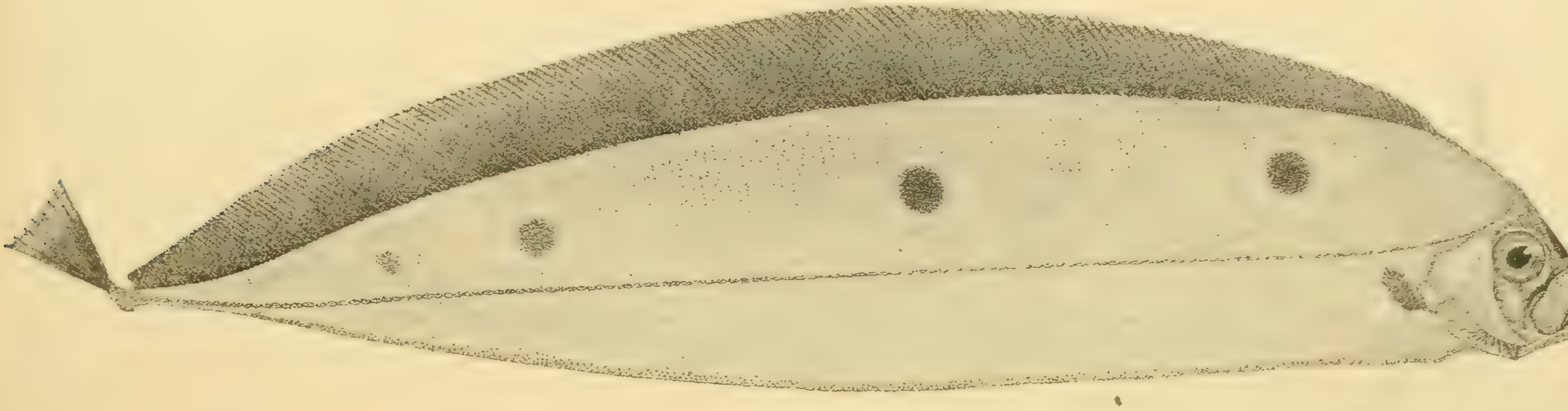

Fig. 83. *Trachypterus arcticus*, ♀, with eggs of a microscopical size, from Vargö (the southern island-belt of Gothenburg), the 22nd of April, 1879. $^2/_9$ of the natural size.

R. br. 6[a]; *D.* (5 l. 6) 150—180; *A.* 0; *P.* (1) 11[b]; *V.* (8 l. 9)[c]; *C.* 8 + (6): *L. lat.* 94—101: *Vert.* 97—100[d].

Syn. *Vogmere* l. *Vogmær*, *Lepturus*, OLAFSEN, l. c. et tab. XLIII; *Trichiurus Lepturus*, MOHR, *Isl. Naturh.*, p. 63.

Gymnogaster arcticus, BRUNN, D. Vid. Selsk. Skr., N. Saml., vol. III, p. 408, tab. B, figg. 1—3; CUV. (*Gymnetrus*), *Règn. Anim.*, ed. 2, tom. II, p. 219; FABER (*Gymnogaster*), *Fische Isl.*, p. 66; FLEM. (*Gymnogaster*), Loud. Mag. Nat. Hist., vol. IV (1831), p. 215, fig. 34; NILSS., *Prodr. Ichth. Scand.*, p. 107; ID. (*Trachypterus*), *Skand. Fn.*, *Fisk.*, p. 162; GTHR, *Cat. Brit. Mus.*, *Fish.*, vol. III, p. 305; COLL., Forh. Vid. Selsk. Christ. 1874, Tillægsh., p. 78; ibid., 1879, No. 1, p. 59; N. Mag. Naturv. Christ., Bd. 29 (1884), p. 69; WINTH., *Zool. Dan.*, *Fiske*, p. 17, tab. III, fig. 7; DAY, *Fish. Gt. Brit.*, *Irel.*, vol. I, p. 217, tab. LXIII; LTKN, Vid. Meddel. Naturh. For. Kbhvn 1881, p. 190; SP. SCHN., Forh. Vid. Selsk. Christ. 1872, No. 15 cum tab.; LILLJ., *Sv.*, *Norg. Fn.*, *Fisk.*, vol. I, p. 462.

Bogmarus islandicus, BL., *Syst. Ichth.* posth., ed. SCHN., p. 518, tab. 101 (ex BRÜNN.); REID (*Vogmarus*), Ann. Mag. Nat. Hist., ser. 2, vol. III, p. 456.

Trachypterus Bogmarus, CUV., VAL., *Hist. Nat. Poiss.*, vol. X, p. 346; REINH. (*Tr. Vogmarus*), D. Vid. Selsk. Naturv., Math. Afh., Deel 7, p. 65 cum 2 tab.; STUWITZ (*Tr.* sp. innom.), N. Mag. Naturv., Bd. 2 (1840), p. 277, tab. III; KR., *Danm. Fiske*, vol. I, p. 292; VAL. (*Tr. Bogmarus*), *Voy. Isl. Groenl.* (GAIM.), *Zool. Poiss.*, tab. 12; LILLJ., (*Tr. Vogmarus*), Vet.-Akad. Handl. 1850, p. 331; MGRN, Öfvers. Vet.-Akad. Förh. 1867, p. 261; ESM., Forh. Naturf. Möde Christ. 1868, p. 522.

Obs. The only tenable distinction hitherto given between this species and its Mediterranean relative, *Trachypterus iris*, is adopted in the above specific diagnosis; but the validity of even this character, as shown by the wording of the diagnosis, is only relative. Our ignorance of the juvenile stages of *Trachypterus arcticus* renders this character still more doubtful, and our present knowledge on this point is most accurately expressed by the following table of averages, derived from the observations of LÜTKEN and EMERY:

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[a] 7, according to REID.

[b] 10—13, according to LILLJEBORG.

[c] 6, according to REINHARDT and LÜTKEN.

[d] According to LÜTKEN.

Length of the body in millimetres	Greatest depth of the body in % of the length thereof.		Length of the head in % of that of the body.		Distance between the vent and the tip of the snout in % of the length of the body.	
	Trach. arcticus.	*Trach. iris.*	*Trach. arcticus.*	*Trach. iris.*	*Trach. arcticus.*	*Trach. iris.*
2,035	19.1	—	11.1	—	51.8	—
1,312	18.2	—	12.4	—	52.9	—
991	17.6	—	14.2	—	54.8	—
923	—	12.3	—	10.6	—	—
917	17.5	—	14.3	—	55.0	—
766		12.8	—	10.6	—	46.7
333	—	18.1	—	13.8	—	52.8
219	—	21.0	—	16.2	—	53.3
130	·	25.7	—	21.0	—	64.8

In the last four columns the rise or fall of the numbers is common to both species, and we can find no consistent difference in any of the three proportions given. Still, it is only in the juvenile stages of the latter species that we can find the same proportions as in the former. This statement applies, however, only to the averages: it is only in the character first given (the depth of the body) that the difference is so marked that the character, to the best of our knowledge at present, is independent of the individual variations. We also see that the direction of development in this case is not the same, for the proportion rises with age in the one form and sinks in the other, assuming that the rule which holds good in this table for *Trachypterus arcticus*, also applies to the earlier stages of this species, which are still unknown.

The Dealfish attains a length of at least $2^1/_2$ metres[a]. The ribbon-shaped body[b] is of fairly uniform depth for the greater part of its length behind the head, but is deepest at about the middle of this part[c], which ends at a varying distance behind the vent. From this point the outlines of the body sharply converge, at about equal angles upwards and downwards, towards the shallow base of the caudal fin[d]. The back behind the head is almost entirely occupied by the continuous dorsal fin[e], the height[f] of which fairly closely follows the lines of the body, with the exception of the fact that in front it is lower, but steeper, and behind higher than the latter. In front of this fin there probably lies in all young specimens a higher occipital or anterior dorsal fin, whose 6 (sometimes only 5) rays are, however, fragile, and generally disappear with age externally, though their stumps may generally be traced in the dorsal edge. Behind the dorsal fin rises the caudal fin described above[g], sometimes in a vertical direction, but sometimes leaning sharply backwards. Of the stunted rays of the caudal fin (the original lower part thereof) the stumps may generally be traced without difficulty, three above and two below the end of the lateral line, as well as the double spine (spinous plate) which is situated in front of them, on the under surface of the end of the tail, with one point directed forwards and the other backwards, and which has replaced the original lowest (rudimentary) ray of the caudal fin. The singular appearance of the fish is further enhanced by the entire absence of the anal fin and, usually, of the ventral fins, though the latter, at least in specimens not more than a metre in length, generally leave traces behind them[h] in the form of a row of stumps (from five or less to ten) on each side of the ventral margin, just behind the perpendicular from the end of the horizontal base of the pectoral fin. The pectoral fins are turned upwards, thin, small, with few rays and rounded at the tip, the first ray being extremely short, the second the thickest and the fifth the longest[a]. The head is comparatively small, its length being always less than the greatest depth of the body[b]; but the eyes are large[c], flattened to the plane of the cheeks, and set about half-way up the body, the distance between them and the frontal profile being equal to their radius. The pupil is oblong and set obliquely downwards in a backward direction.

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[a] The largest specimen from Norway examined by Collett was 246 cm. long. The occurrence alleged by fishermeh of specimens 3 m. in length has not been confirmed up to the present.

[b] The body, it is stated, becomes considerably thinner after death and on dry land. In the specimens preserved in spirits it is thickest at the head, across the upper articulation of the preoperculum, where the breadth measures 3 or 4 % of the length.

[c] Even in specimens from 830 to 985 mm. in length, according to Lütken, the greatest depth of the body may be no more than 15 or 16 % of the length; but it afterwards rises to at least 20 % thereof — according to Sparre-Schneider, 21·4 %. The greatest depth usually occurs in front of the vent, but in a specimen about 11 dm. long, from West Fjord (Norway) the body is deepest just at the vent.

[d] The least depth of the tail measures only from about 1 to $2^1/_2$ % of the length of the body (the latter measurement according to Reinhardt). Still, it is so strongly compressed that at this point the thickness (breadth) of the body is only about $^1/_3$ of the depth.

[e] The roughness of the rays of the dorsal fin, caused by small spines along their sides, is extremely inconstant. Sometimes, especially in old specimens, all the rays are smooth to the touch, if we except the basal spine on each side.

[f] The length of the longest ray of the dorsal fin, about the 100th from the beginning, is about half the greatest depth of the body.

[g] In specimens between 830 and 1,505 mm. long the length of the caudal fin varies, according to Lütken, between 18 and $11^1/_2$ % of that of the body; in a specimen 1,870 mm. long he found the length of the caudal fin to be only $9^1/_3$ % of that of the body.

[h] In a specimen 76 cm. long Sparre-Schneider found the stump of the first ray of the ventral fin to measure 43 mm. in length.

When the mouth is closed, the head, when seen from the side, is of a quadrilateral shape. The straight profile of the forehead and snout slopes downwards almost at a right angle to the ascending under surface of the lower jaw, the point of which projects, however, beyond the upper jaw. The corners of the mouth are now entirely hidden at the sides, being covered by the intermaxillary and the maxillary bones; but the upper margins of the lower jaw rise vertically within the gape. The hind corner of the head, formed by the suboperculum, is somewhat rounded and elongated. The lower corner of the square is formed by the angular part of the lower jaw, which is produced behind into a blunt spine[d]. The cheek is naked; only in front of the eye do we find two suborbital or preorbital bones, the lower being so narrow that it only just separates the eye from the point of the high, triangular branch of the lower jaw, which, in its turn, is covered by the broad, thin maxillary bone[e]. The latter, like all the opercular bones, is of a thin, spongeous texture, externally cavernous, with radiating elevated ridges. It is obliquely linguiform, the breadth being rather more than half the length. The preoperculum is crescent-shaped, the operculum almost like the upper half of the preoperculum in shape, the part of the suboperculum which is externally visible, narrow, and the interoperculum, which forms the greater part of the lower margin of the gill-cover, of fairly uniform breadth. All these bones are membranous at the margin. The gill-openings are large, their height[f] being about equal to the total length of the interoperculum and suboperculum. The branchiostegal membrane is united to the narrow isthmus back to a point vertically below the hind margin of the eye; but in front of this point it hangs in a fold across the isthmus, thus appearing double, when the jaws are drawn back. At these times too, it is covered, together with the whole of the branchial apparatus and the isthmus, by the interopercula and the branches of the lower jaw.

But the appearance of the head is quite different when the mouth is protruded. The nasal processes[g] of the intermaxillary bones extend right up to the occiput, where they may slide to and fro in the deep groove in the frontal bones. When they are protruded, they draw with them the maxillary bones, which are only loosely connected with the palate, and are thus capable of extensive protrusion. The snout now attains a length which may even exceed that of the rest of the head, and acquires an appearance, when seen from the side, not unlike that of a swine's snout. Now, when the branchial apparatus is expanded, the hyoid bone, together with the broad ceratohyoid bones, projects down below the isthmus, and the branchiostegal membrane emerges from the opercular apparatus.

The nostrils are comparatively small, the posterior being long, but narrow, and situated in the form of a perpendicular slit close to the anterior upper margin of the orbit. The anterior nostril is separated from it by a dermal bridge.

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[a] The pectoral fins are perfect in a specimen caught in 1879, on the lee of Vinga (Gothenburg). Their length is nearly 4 % of that of the body or $^{1}/_{5}$ of the greatest depth of the latter.

[b] In the specimen from Vinga (925 mm. long) the length of the head, measured from the middle of the margin of the upper jaw (the tip of the snout), when drawn back, is 11·3 % of that of the body. This coincides with Lütken's measurement of a *Trachypterus arcticus* 830 mm. long, and also with Emery's measurements of the largest specimens of *Trach. iris* in his possession (1,120—1,410 mm. long). According to Lütken, however, in specimens of *Trach. arcticus* about 1 m. in length, the *average* length of the head is 14·2 % thereof, in specimens about 13 dm. long, 12·4 %, and in specimens about 2 m. long, 11·1 %.

[c] In specimens about 1 m. long the longitudinal diameter of the orbit is about 30 % of the length of the head. In specimens $1^{1}/_{2}$ m. in length it may sink to 25·8 % of the length of the head, according to Lütken. In many cases, however, the eye on the one side of the head is at least somewhat larger than that on the other.

[d] In the specimen from Vinga the length of the right branch of the lower jaw is 57 % of that of the head, of the left only $52^{1}/_{2}$ %. Though the snout has been damaged, this does not seem enough entirely to explain the difference. In the other two specimens preserved in spirits in the Royal Museum, however, there is no such difference: but the gape is crooked when the mouth is protruded.

[e] In the specimen from Vinga the length of the right maxillary bone is 40 % of that of the head, of the left only 34·3 %. Cf. the preceding note.

[f] In the specimen from Vinga the height of the gill-openings is $^{2}/_{3}$ of the length of the head.

[g] In the specimen from Vinga the length of the nasal processes, together with the anterior height of the body of the intermaxillary bones, is 75 mm. or very nearly $^{3}/_{4}$ of the length of the head.

The jaw-teeth are pointed and fixed, but small and sparse, varying from about 20 to 4 or less in either jaw. Their number is sometimes the same on each side, but they are usually unsymmetrical in this respect. In the lower jaw they are set on the inside of the margin itself, but in the upper jaw, on the other hand, further in, on the inside of the intermaxillary bones. The vomerine teeth are like the jaw-teeth, but still fewer (from 5 to 1) and more irregular in size. The outer margin of the upper pharyngeals is furnished with similar, but longer teeth, whereas the lower pharyngeals are toothless. The gill-rakers are short, their number on the first branchial arch being 13.

The œsophagus widens just behind the pharynx, and runs straight back to the pylorus (fig. 84), without forming any distinct stomach; but a short blind sac rises from the end of the pylorus. From the pylorus the first division of the small intestine (duodenum) curves straight forward under the œsophagus, surrounded by extremely well-developed and numerous pyloric appendages. Just in front of the anterior end of the mass of pyloric appendages the small intestine turns back under the former, and in a line with the pylorus, where the spleen is also situated, passes into the large intestine (rectum), which runs straight back, and above the vent, just behind the middle of the body[a], forms a geniculate curve down to the anal opening.

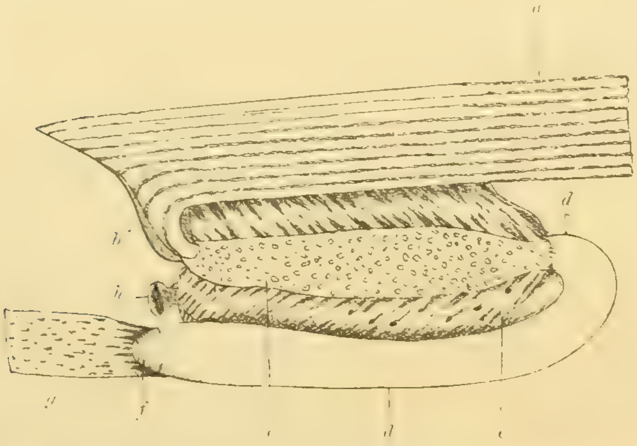

Fig. 84. Part of the intestinal canal of *Trachypterus arcticus*. *a:* the stomach, opened and with the right side folded back to show the interior; *b:* the pyloric part of the stomach; *c:* the duodenum or first division of the intestine; *d*, *d:* the second division of the small intestine; *e:* the pyloric appendages, the openings of which are shown in the section of the duodenum; *f:* the valve at the passage of the small intestine into the rectum; *g:* the rectum, opened; *h:* the spleen. After REID.

The course of the lateral line is fairly straight, but just behind the head it slopes downwards, and thus comes nearer to the belly than to the back[b]. With this exception it follows the direction of the spinal column, externally showing the position of the latter within the body. Each of its plates, at least in specimens less than 1 m. in length, may be armed with a spine pointing in a forward direction. The spines, however, seem as a rule to disappear with age.

At first sight the whole body, with the exception of the spines belonging to the lateral line and the dorsal fin, is apparently smooth, distinct, verrucose tubercles appearing only at the ventral margin. But on closer examination the surface of the body proves to be divided into small squares, consisting of flat tubercles, arranged in a kind of mosaic. These tubercles are covered by the thin, naked epidermis, which is tin-coloured, but has a silvery lustre. The ground-colour is diversified by two or three coal-black spots, of the same size as the eye or smaller, which are round or oblong (in the latter case set obliquely), on the upper part of the sides. Two of these spots belong to the abdominal part, and the third, which seems to be soonest obliterated during growth, is set on the caudal part of the body[c]. The forehead, the top of the snout and the tip of the lower jaw are also black. All the fins are blood-red.

The true home of the Dealfish is unquestionably in the deeper, if not in the deepest, parts of the North Atlantic. Of its manner of life at these depths we know nothing. It is only by accident that it can come into the hands of man, for our ordinary fishing-tackle is useless at depths so great. Like many other deep-sea fishes, however, when some fortuitous cause has suddenly raised it above the depth where the pressure is suitable for its organization, it is borne to the surface against its will, and then floats helplessly about, unable to descend again. But on one or two occasions it has shown its capacity of adapting itself to water of a less depth: NILSSON states that in Norwegian Finmark it is sometimes taken in autumn, in the Herring-seines; and Day describes a specimen 174 cm. long, which was taken in a stake-net off Montrose. When the Dealfish has been found in the Sound itself, it has also naturally had a long stretch of comparatively shallow water to traverse. The specimen which Lilljeborg obtained in 1848 off the coast of Norwegian Finmark, was also taken with a dredge, at a depth of 2 or 3 fathoms; and Nilsson probably refers to this specimen when he says that the Dealfish "is sometimes discovered lying at the bottom by the fishermen, and is then described as shining like the brightest silver. The fishermen let down a *dragg*[a] and strike the fish, for it is a very poor swimmer and by no means quick in its movements." These instances, however, are rare, and in the great majority of cases the Dealfish has been found cast ashore by the waves or floating in its death-struggles at the surface of the water. Up to the present time nothing has been found in its stomach to suggest the idea that the object of its wanderings is the capture of some prey which may have fled to the higher regions of the ocean[b]. Collett supposes that most of the specimens that have migrated from deep water, have been females[c]; but it is far from probable that it is to deposit their eggs that they make their way to the shallows; for the fry have never yet been found on any of the Atlantic coasts.

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[a] In the specimen from Vinga the distance between the tip of the snout and the vent is 54 % of the length of the body, excluding the caudal fin. According to LÜTKEN this proportion sinks, *on an average*, with increasing age to 51 %, and may even be as low as 49 %.

[b] Where the body is deepest, just in front of the vent, in the specimen from Vinga, the distance between the lateral line and the ventral margin is 72 % of that between it and the dorsal margin.

[c] The distance between the first spot and the tip of the snout is from about 21 to 26 % of the length of the body, and between the second spot and the tip of the snout from about 46 to 50 % of the length of the body. In the specimen from Vinga we find a distinct trace of a fourth (posterior) spot.

The eye-witnesses of the movements of this fish declare that it swims on its side, like the Flounders. Their conduct under circumstances foreign to their nature and when probably suffering from some disease, cannot be unreservedly recognised as normal. But that this is possibly their custom, or at least a habit to which they often resort, is apparently shown by the difference between the two sides of the body that occurs in certain individuals, which in a certain degree reminds us of the want of symmetry in the Flounders, and was first remarked by Nilsson. Lilljeborg was informed by the fishermen of Finmark, with regard to his specimen, that the right eye was brighter than the left. According to Lütken's table of measurements the eyes were of different size in four of the ten specimens which he measured in this respect[d]. In one of the three specimens preserved in spirits in the Royal Museum, as we have remarked above, both the jaw-bones on the right side are larger than those on the left; and though the other two specimens are symmetrical in this respect, the mouth, when protruded, is oblique. According to the observations hitherto recorded as to the arrangement of the jaw-teeth and the vomerine teeth, we must regard the cases as exceptional in which their number is the same on both sides. A certain want of symmetry must, therefore, be acknowledged[e], even if it be merely one of the numerous individual variations of this genus.

The Dealfish belongs to the abyssal depths between Iceland and the north of Norway. It has oftenest been met with north of the polar circle, but also on several occasions off the south of Norway and on the Scotch coast. It has been observed even on the coast of Ireland. In 1823 Marklin brought home from the north of Norway the first Scandinavian specimen on record[f], its length being about 156 cm.; and in 1837 S. Lovén caught two specimens in West Fjord, the one about 11 dm. long and the other about 13 dm. Since this time the Dealfish has often been met with on the coast of Norway: between 1875 and 1883, according to Collett, 10 instances of its capture were recorded. In the autumn of 1827 a specimen came ashore between the Skaw and Fredrikshavn; on the 6th of May, 1879, another specimen was cast ashore to the south of the Skaw; and on the 8th of February, 1881, a third specimen, 830 mm. in length, the smallest on record, was taken about 6 miles south of the Skaw, and forwarded to Copenhagen Museum, where another specimen is also preserved which was received in June, 1886, from Frederikshavn[g]. Several specimens have thus been taken in Denmark, but only two in Sweden. The first was found on the 22nd of April, 1879, on the lee of Vinga, in the island-belt of Gothenburg, and was received by Mr. N. Molin on behalf of the Royal Museum; and the second, according to Lilljeborg, was taken in the autumn of 1880, in the neighbourhood of Helsingborg, and is now preserved in the Museum of Lund University.

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[a] A kind of harpoon-dredge with which the fishermen draw up the seals which have sunk to the bottom after being shot.

[b] It might otherwise be supposed that, when it is taken in the Herring-seines, it has followed the Herrings from deep water.

[c] In the long ovaries of a female 246 cm. in length Collett estimates the number of the eggs at between 550.000 and 580.000. The testes, according to Lütken and Sparre-Schneider, are long and fimbriated.

[d] L. c., p. 204.

[e] Cf. Kroyer, l. c., p. 599.

[f] Cf. Nilss., *Prodr.*, l. c. The specimen, which is still preserved in the Royal Museum, is damaged and dried.

[g] Petersen, Vid. Meddel. Naturh. For. Kbhvn 1884, p. 156.

On account of the manner of its occurrence the Dealfish can be of no economical value to man, though, according to information gained by **Lilljeborg** in Finmark, it is fairly fat, "but the fat is soft and oily, and readily drains from the body after death."

Genus REGALECUS.

Anterior end of the head truncate, when the mouth is closed, and formed by the perpendicular lower margin of the under-jaw. Sides of the body, which is silvery, furnished with longitudinal, terete or flat ridges, but without spines on the lateral line[a]. *Caudal fin, anal fin and jaw-teeth wanting in full-grown specimens*[b]. *Number of rays in the dorsal fin more than 200*[c]. *Branchiostegal rays 6*[d]. *The bottom of the stomach siphonal, elongated in a tubular form behind the vent.*

Our knowledge of the genus *Regalecus*[e], the genus of the *Kings of the Herrings*, which was first established by **Ascanius**[f], but soon afterwards received of **Bloch**[g] a name more widely-known since that time, that of *Gymnetrus*, is still more imperfect than of the preceding genus. *Regalecus* ranks in more than one respect as an intermediate form between *Trachypterus* and *Lophotes.* The protruded occipital region of the latter genus, which appears to a certain degree in the larvæ of *Trachypterus*, is fairly distinctly reproduced in adult specimens of *Regalecus*, and in this genus the lateral line also extends straight forward along the head above the eyes, to judge by the few specimens described that have been perfect in this respect. The most characteristic point, however, is the structure of the stomach and the intestinal canal. Whereas in *Lophotes* the vent lies near the tip of the tail, in *Regalecus*, as in *Trachypterus*, it is placed considerably farther forward — in this genus always in front of the middle of the body. In *Regalecus*, however (fig. 85), the bottom of the stomach (the posterior end above the pylorus) is elongated into a long, tubular blind sac, which extends back almost to the very end of the tail. Still, in other respects, the digestive canal is exactly similar to that of *Trachypterus*, as described above.

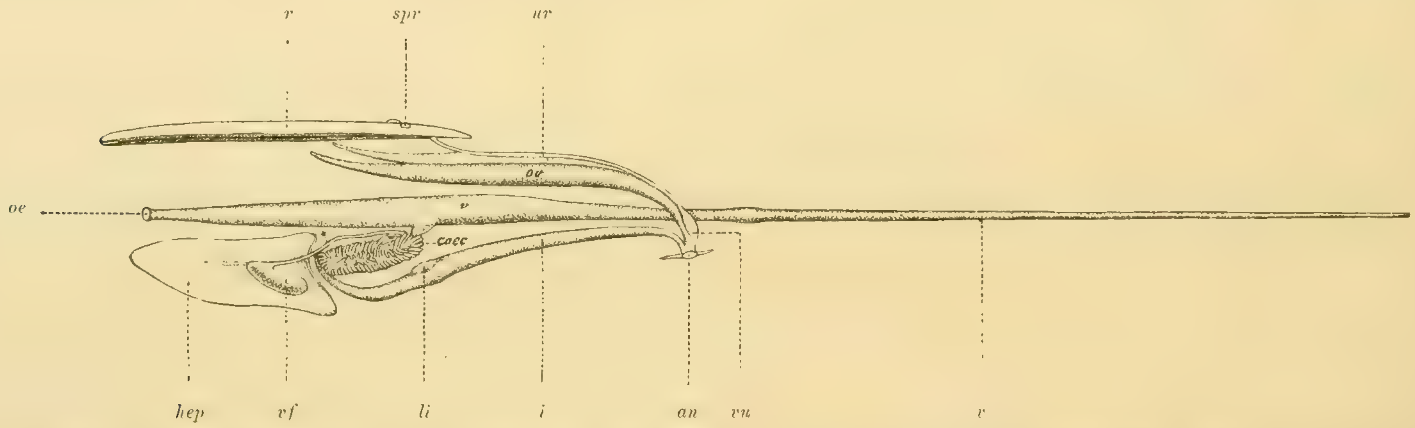

Fig. 85. Viscera of *Regalecus glesne*, after **Hancock** and **Embleton**. *r:* kidney; *spr:* supra-renal bodies; *ur:* urethra; *ov:* ovary; *oe:* œsophagus; *v, v:* stomach; *hep:* liver; *vf:* gall-bladder; * ductus choledochus communis; *coec:* pyloric appendages; *li:* spleen; *i:* intestine (rectum); *an:* vent; *vu:* urinary bladder.

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[a] In *Regalecus* the spines at the base of the dorsal rays are generally wanting. They may also be present, but are even then small: — see **McCoy**, *Prodr. Zool. Vict.*, dec. XV, p. 169.

[b] **Lindroth** states, however, that in one specimen he found "the head very short and blunt, with distinct strong teeth." **Valenciennes** found teeth in both jaws in *Regalecus gladius*, but they were "so fine and short that they were imperceptible to the touch." The same words recur in **Jourdain**, *Comptes Rendus* 1872, p. 59.

[c] The statements in which the number of rays is less, have never been confirmed on examination of entire specimens.

[d] **Hancock** and **Embleton**'s "7 branchiostegal rays" is due, according to **Günther**, to a confusion between the suboperculum and these rays.

[e] Latin *rex* and *halec* (*Herring*, strictly Herring-brine).

[f] *Icon. Rer. Nat.*, cah. II, p. 5 (1772).

[g] *Ausl. Fisch.*, part. IX, p. 94.

LÜTKEN has specified certain osteological distinctions between the genera *Regalecus* and *Trachypterus*, chiefly affecting the general structure of the skeleton. In *Regalecus*, which is usually of considerably greater dimensions, in spite of this the skeleton is much looser, a circumstance which is, however, consistent with the fact that *Regalecus* is a deep-sea genus of a still more marked description. As we have seen above, there is no lack of characters to distinguish between the two genera; but on the other hand, it cannot be denied that they are very closely related to each other, especially if the changes of development be taken into consideration.

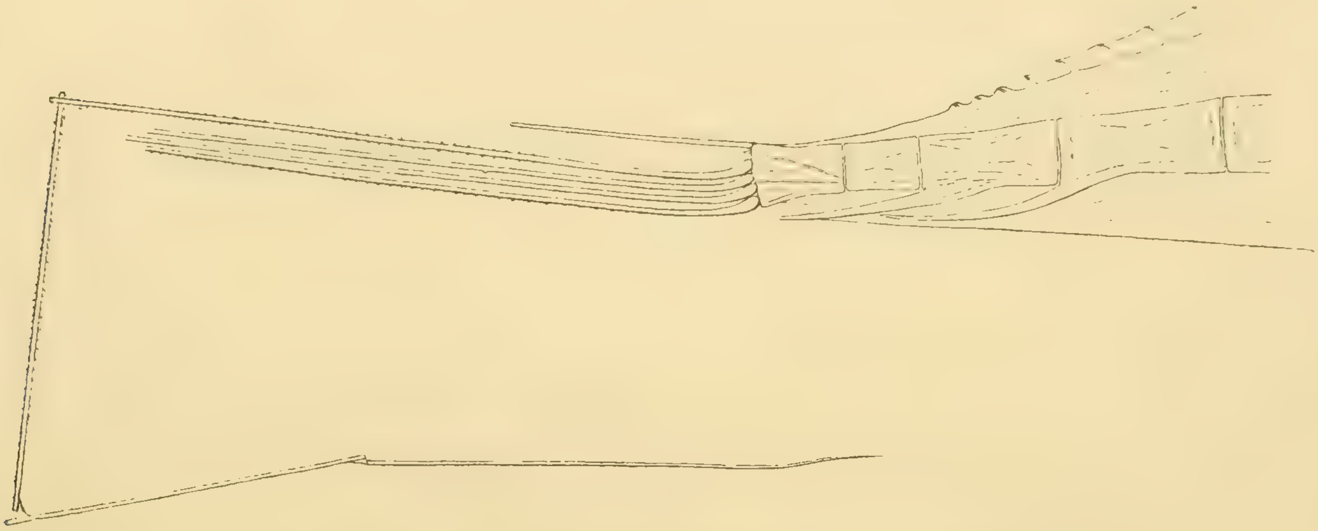
Fig. 86. Caudal fin of a *Regalecus gladius* 36 cm. long, from Messina.

The earliest stages have hitherto been almost unknown; but by the kindness of Professor LECHE we are here enabled to give some details with regard to a specimen of *Regalecus gladius*, 36 cm. long, which he received at Messina.

The head is perfect in the essential points, and shows that extensive elongation of the preoperculum, the interoperculum and the hyomandibular, together with the quadrate bone, downwards and forwards to a point in front of the perpendicular from the anterior margin of the eye by a distance equal to the longitudinal diameter of the eye, which sets the articulation of the lower jaw in such a position that the lower margin of the latter is perpendicular, when the mouth is closed, and thus forms the front of the head. The jaw-teeth are wanting. The operculum is triangular, with the hind corner, which forms the end of the head, obtusely rounded. Beneath its inferior side lies the suboperculum, which is of fairly uniform breadth, but somewhat broader behind than in front. Only the anterior part of the occipital fin is persistent, i. e. the first, strongest ray and the next four. The tips of these rays are broken off short, but their length is still about $^1/_3$ greater than that of the head. Of the rays behind these there is no trace, in front of the dorsal fin proper, which begins in a line with the middle of the operculum. Each of the ventral fins contains only one ray, even this being broken, but in the left fin about equal in length to the head. The pectoral fins are damaged and indistinct. The depth of the body, which is considerably less than the length of the head, gradually decreases from the occiput to the very end of the tail, which is furnished with a long, though damaged and broken, caudal fin. This fin (fig. 86) consists of seven simple and unarticulated rays, the four lower ones articulating with the hypural bones, which are directed straight backwards, and the three upper with the end of the urostyle. The second and third rays from the top, however, are rudimentary, and the fin is thus divided into two parts, with one ray at the top entirely separated, to all appearance, from the lowest four rays by the interval referred to. All the rays are broken, but the pieces of the middle ray are still united by a thin filament, and end in an extremely fine filiform tip. This ray, as well as the uppermost and lowest rays, is also rough at the sides with two rows of spines pointing in opposite directions, a character which reminds us of the preceding genus. When perfect, this ray seems to have been half as long again as the head. An essential distinction between this genus and *Trachypterus* may thus be drawn from the circumstance that in the former the rudimentary rays are situated at the top of the caudal fin, in the latter at the bottom. In this circumstance we may perhaps find a partial explanation of the more general retention of the caudal fin in *Trachypterus* and its almost invariable loss in *Regalecus*. The other differences, however, affect only the degree and not the direction of the development.

We thus retain the genus *Regalecus*, but only as the expression of an intermediate stage between *Lophotes* and *Trachypterus*.

It is perhaps a matter of doubt whether more than one species is known from the Atlantic, the Mediterranean, the East Indies[a] and Australia; but it is apparently certain that only one species of this genus belongs to the north of the Atlantic and the Scandinavian fauna, that same species which on many, if not all, occasions has given rise to the mysterious accounts of the "great sea-serpent".

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[a] It seems hardly probable that *Regalecus Russellii* from Vizagapatam is a distinct species. It has never reappeared since 1788, and there is no specimen of it in existence. Even SHAW (*Gen. Zool.*, vol. IV, p. 195, tab. 28) regarded Russell's Gymnetrus as an early stage of the development of *Regalecus glesne*.

THE KING OF THE HERRINGS (SW. SILLKUNGEN).

REGALECUS GLESNE.

Fig. 87.

Length of the head less than the greatest depth of the body[a]. *Tail probably elongated to a fine point with the dorsal fin gradually disappearing posteriorly, but in all recorded specimens from the Atlantic broken off short, with the point stripped both of the dorsal fin and the caudal and ending in a naked vertebra, while the dorsal edge slopes downward, generally in an oblique S-curve, behind the last ray of the dorsal fin. The first (10—15 or 17?) rays in the dorsal fin are elongated and erected into a (continuous (?) or) bifid, cristate, occipital fin: the 2nd, 3rd, 4th and 5th of these rays are the slenderest, and the 1st the thickest and, together with the 6th, probably the longest; most, if not all, of these rays with a foliate extension of the membrane at the tip. The rest of the dorsal fin lower, its greatest height coinciding with the greatest depth of the body and measuring from* $^1/_3$ *to* $^1/_4$ *of the latter. Base of the pectoral fin horizontal and about equal*[b] *in length to the fin itself or at least half thereof. Only the first ray of the ventral fins persistent, being thick and long, with a foliate extension of the membrane at the tip (and (?) a triangular extension thereof at the second third of the length of the ray, on the inner margin). Longitudinal diameter of the eye (in specimens 3 metres or more in length) about equal to the thickness of the head or from* $^1/_5$ *to* $^1/_6$ *of the length of the latter; and the eyes set in the upper anterior half of the head. Maxillary bones, supraorbital part (of the frontal bones) and opercular bones irregularly cavernous and striated with radiating grooves and ridges. Frontal profile concave in its slope from the occiput. Lateral line forming a chain of oblong scales, each pierced with a tube, "which are quite thin and set loosely in the skin." On each side of the body, which is of a silvery lustre, 4—6 longitudinal, dark brown ridges, granulated with rough tubercles and separated by shallow grooves with smoother skin. These ridges are obliquely traversed in front by the lateral line, which just in front of the vent takes its place at the lowest fourth (further back at the lowest fifth and finally at the lowest seventh) of the depth of the body*[c]. *Body transversely marked with oblique, black bands or rows of spots, which are usually interrupted at the lateral line*[d]. *Dorsal fin and the ventral ray red*[e]. *Forehead and the inside of the mouth black. Number of gill-rakers on the first branchial arch 42 or 43.*

R. br. 6; *D.* $\frac{10-15}{200-400}$; *P.* 11—13; *V.* 1; *Vert.* circ. 110.

Syn. *Ophidium glesne*, ASCAN., D. Vid. Selsk. Skr., N. Saml., Deel III, p. 421; ID. (*Regalecus*), *Icon. Rer. Nat.*, cah. II, p. 5, tab. XI; NILSS., *Prodr. Ichth. Scand.*, p. 105; CUV., VAL. (*Gymnetrus*), *Hist. Nat. Poiss.*, tom. X, p. 366; GTHR (*Regalecus*), *Cat. Brit. Mus., Fish.*, vol. III, p. 310; COLL., Forh. Vid. Selsk. Christ. 1874, Tillægsh., p. 84; ibid. 1883, No. 16, p. 7; N. Mag. Naturv., Bd. 29 (1884), p. 71; LILLJ., *Sv., Norg. Fisk.*, vol. I, p. 475.

Regalecus remipes, BRÜNN, D. Vid. Selsk. Skr., N. Saml., Deel III, p. 414, tab. B, figg. 4 et 5; WALB., *Art. Gen. Pisc.*, App., p. 696, tab. 3, fig. 4; BL., SCHN. (*Gymnetrus*), *Syst. Ichth.*, p. 482, tab. 88.

Gymnetrus Ascanii, LINDR., Vet.-Akad. Handl. 1798, p. 290.

Gymnetrus Hawkenii, BL., *Ausl. Fish.*, part. IX, p. 95, tab. 423; BL., SCHN. (*G. Hawkinsii*), l. c., p. 481; CUV., VAL., l. c., p. 372; YARR., *Brit. Fish.*, ed. II, vol. I, p. 221.

Gymnetrus Grillii, LINDR., l. c., p. 288, tab. VIII; CUV., VAL., l. c., p. 370; NILSS., *Skand. Fn., Fisk.*, p. 169; GTHR, l. c., p. 311.

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[a] The average length of the head is about 14 % (13—15 %) of the distance between the vent and the tip of the snout or about 70 % (67—73 %) of the greatest depth of the body, which in its turn measures on an average about 25 % (22—26 %) of the distance between the vent and the gill-opening or about 20 % (18—22 %) of the distance between the vent and the tip of the snout, which latter distance, in specimens not more than 45 dm. in length, is about 40 % of the length of the body.

[b] According to LINDROTH and WRIGHT, as well as MCCOY.

[c] Before it ends at a distance from the tip of the tail which measures at least about $^1/_{18}$ of the length of the body according to MCCOY.

[d] On the hind part of the body, though not on the hindmost part of the tail, there also appear, according to MCCOY, round black spots, arranged in fairly regular, longitudinal rows.

[e] Pectoral fins white, according to MCCOY.

Gymnetrus Banksii, Cuv., Val., l. c., p. 365; Hancock and Embleton, Ann. Mag. Nat. Hist., ser. 2, vol. IV, p. 1, tab. I et II; Rich. in Yarr., *Brit. Fish.*, ed. II, Suppl., p. 27; Gthr (*Regalecus*), l. c., p. 309; Day, *Fish. Gt. Brit., Irel.*, vol. I, p. 220, tab. LXIV; (?) McCoy, *Prodr. Zool. Vict.*, dec. XV, p. 169, tab. 145.

Obs. In this genus too, Lütken has paved the way for a reasonable reduction of the number of species hitherto recognised. Still, it is as yet an open question whether the Mediterranean *Regalecus gladius*[a] is really a distinct species from the Atlantic *Regalecus glesne*. The only tenable distinction hitherto suggested consists in the more elongated body of the former species; and in this genus as in the preceding one, the Mediterranean species is said to be marked by the characteristic that in its case the body is deepest at the head or just behind it. It is a thought which naturally suggests itself, that this difference may be explained as a difference of growth. — the largest specimen described by Valenciennes of the Mediterranean species was 268 cm. in length, and there is no instance of so small a specimen of *Regalecus glesne*. It is also hardly probable that the individual variations of this genus are less than those of the preceding one[b]. Layard's[c] specimen of *Gymnetrus capensis*[d] from the Cape of Good Hope, a form which Günther referred to the same species as *Regalecus gladius*, probably measured, when entire, nearly 4 metres in length and about 26 % of the distance between the vent and the gill-opening in depth, the latter measurement even exceeding the average depth of *Regalecus glesne*. According to Valenciennes, *Regalecus gladius* is furnished with more than 200 rays in the anterior part of the dorsal fin, measured for a distance of 1,678 mm., while

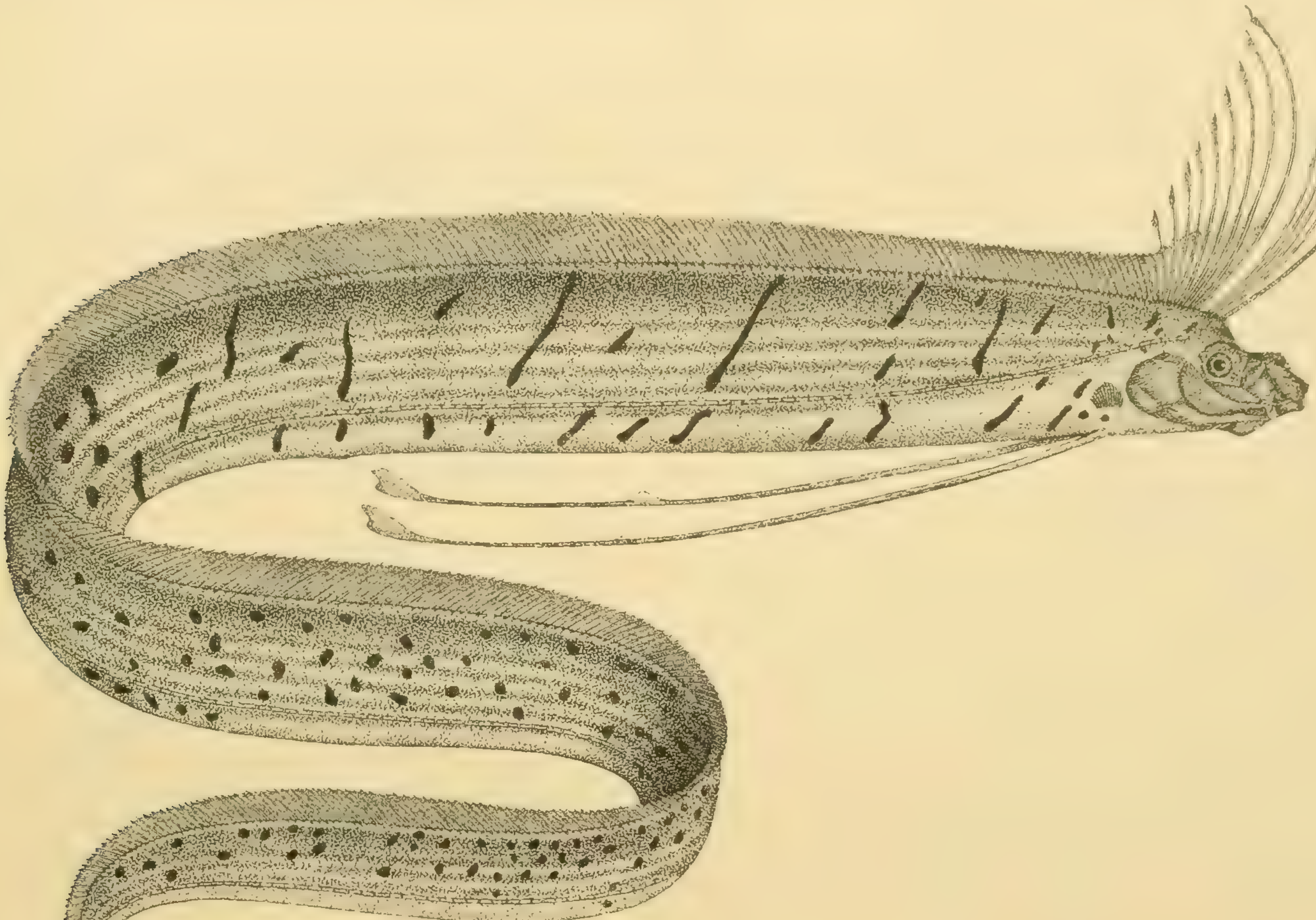

Fig. 87. *Regalecus glesne.* The figure is partly schematic. About $^{1}/_{10}$ of the natural size.

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[a] *Cepola gladius*, Walb., *Art. Gen. Pisc.*, App., p. 617; *Gymnetrus gladius* + *Gymnetrus telum*, Cuv., Val., l. c., pp. 352 and 361, tab. 298—299.

[b] In the specimen of *Regalecus glesne* from *Alstahoug* (1859 — Bergen Museum), which had probably been 356—360 cm. in length when perfect, the greatest depth of the body is only slightly more than $^{1}/_{15}$ of the length of the body, according to Collett, or, according to Lilljeborg, than $^{1}/_{14}$ thereof or about 22 % of the distance between the vent and the gill-opening. The latter measurement agrees closely enough with Valenciennes's figure of *Gymnetrus telum*.

[c] Proc. Zool. Soc. 1868, p. 321.

[d] Cuv., Val., l. c., p. 376.

in the same space *Regalecus capensis* should only possess 163 rays: and in a specimen of *Regalecus glesne* from Bohuslän this space should presumably contain only 103 rays. Thus we might here expect to find a specific distinction expressed without difficulty; but in fishes of so loose a structure as these, and considering that in *Regalecus glesne* we are compelled to recognise a variation in the rays of the dorsal fin so considerable as to range between 200 and 400, the difference in the degree of contraction of the body may considerably affect the results arrived at, and the individual variations render the character worthless. As a general rule we may reasonably assume that the rays of the dorsal fin are more densely set in young specimens; but in the largest example known, LINDROTH'S specimen from Hitteren, there are 47 rays in a space which in the Royal Museum's smaller specimen, from Bohuslän, contains only 40 rays, and according to COLLETT, in the Stavanger specimen (1881 — Stavanger Museum), which in size was probably almost exactly intermediate between these two specimens, there are on an average 43 rays in a similar portion of the dorsal fin.

The relation between these three specimens thus contradicts the above rule; and a further example of the individual variations may be found in the *Regalecus* from the waters between the coasts of Tasmania and Victoria, in May 1878, which specimen McCOY (l. c.) referred to the same species as the Atlantic King of the Herrings, assuming that the identity of the species may be defended, as seems not improbable. This Australian *Regalecus* was only 414 cm. long, and only an insignificant part of the tail was wanting (the last remaining ray of the dorsal fin was only 2 mm. long and the tail, at the point of fracture, only 13 mm. deep). It was thus at least 1 metre shorter, though more nearly perfect, than the Hitteren specimen; but it had 406 dorsal fin rays, in addition to the 17 rays of the high occipital fin. In the shape of the body — which was, however, considerably shallower, a characteristic which McCOY supposes to belong to the male — in the coloration and in other respects[a] this *Regalecus* so closely resembles the Atlantic species that it is only our insufficient knowledge of the latter species that calls for caution in the identification of two species from localities so distant.

We may still acknowledge the truth of NILSSON'S words: "It is impossible strictly to define the distinction between the species of this genus". But it seems most probable that as yet we know only one species of the genus; and the fragmentary knowledge we possess of the adult stages of this species — no entire specimen of the Atlantic *Regalecus glesne* has yet been scientifically examined — may safely be supplemented from the better-preserved specimens of the Mediterranean and Australia.

The Royal Museum possesses the remains of two specimens of *Regalecus glesne.* Of the first specimen, which was found on the 12th of August, 1797, off the island of Hitteren, near Trondhjem, and which was the original of LINDROTH'S description and figure (l. c.) of *Gymnetrus Grillii*, there is left only the skin of the left side behind the head and the ray of the left ventral fin. This part, which was stuffed by LINDROTH for GRILL'S museum at Söderfors, is nailed to a board. The head and the dorsal fin are artificial, as they are shown by LINDROTH in his figure of the stuffed specimen. This example is remarkable in several respects. It is the longest specimen hitherto preserved and examined. The number of rays in the dorsal fin is greater, and the vent is situated farther forward, relatively to the length of the body, than in any other Atlantic specimen on record. The last two characteristics may thus be interpreted as expressions of the changes of growth; but the difference between it and the other Atlantic specimens in these respects is so great that some standard by which to test the correctness of the description, may well be required, and the specimen fortunately offers us one, even in its incomplete state. The interspinal bones are still to be found at the dorsal edge, throughout the greater part of the length of the body, and, posteriorly at least, are so distinct that they may be counted without difficulty. The total length of the base of the dorsal fin left is 515 cm. The part occupied by the last 100 interspinal bones measures 945 mm., by the next 100 in front of them 1,305 mm., and by the next 100 1,505 mm. The remaining 1,395 mm., where the interspinal bones are now partly indistinct, can hardly have contained less than 106 rays, the number of artificial rays set there by LINDROTH. It is, therefore, highly probable that LINDROTH'S statement that the dorsal fin contained 406 rays, is based on his examination of the fresh specimen, just as it was when he received it and before the dorsal fin was lost. This assumption finds strong support in McCOY'S description of the Australian *Regalecus*, which had still more rays in the dorsal fin. Again, with regard to the position of the vent LINDROTH gives a definite measurement (4 Sw. ft. 7 in. = 1,361 mm.) of the distance between it and the head, a statement which almost exactly applies to the stuffed skin, where the vent itself is 25 mm. long, and is stopped with red putty. This distance is indeed less in proportion to the length of the body than in any other specimen known (nearly $25^{1}/_{2}$ %, instead of the usual average $34^{1}/_{2}$ %); but in proportion to the depth of the body as given by LINDROTH ($25^{1}/_{2}$ % of this distance) it corresponds fairly closely to the same measurement in several of the specimens best known in this respect[b].

The second specimen in the possession of the Royal Museum is the only Swedish specimen of *Regalecus glesne* discovered up to the present date. It was found on the 28th of March, 1879, about 3 miles west of Koster, on the shore of an islet called Burholm, and secured for the Museum by Mr. G. v. YHLEN, Inspector of Fisheries. The greatest depth of the body, according to Coastguard MATTSON'S statement, was a little more than a foot (3 dm.) and the thickness about 4 in. (1 dm.). The length was $25^{1}/_{4}$ ft. (?). The colour was "grayish on the sides and white on the back, covered with a bright dust". A fin 3 in. (75 mm.) high ran from the occiput to the tail. When the specimen was secured for the Royal Museum, however, it had been considerably damaged by the surf and the ravages of birds. The upper part of the black forehead, with the groove for the nasal processes of the intermaxillary bones, is, however, preserved, and on the occiput we can find traces of the anterior fin-rays, the first of which points in a forward direction and is set at the end of the groove just mentioned. The rest of the head is crushed to pieces, and the nasal region, with all the jaw-bones, is wanting. The remainder of the body from the first ray of the dorsal (occipital) fin is 245 cm. in length, and the greatest depth, which occurs at a distance of from 5 to 11 dm. from this ray, is $29^{1}/_{2}$ cm. At this point the lateral line (fig. 88, *a*) lies at a distance of 70 mm. from the ventral edge and 226 mm. from the dorsal. The greatest thickness is now only 36 mm.; and, according to MATTSON'S statement, the body has thus shrunk to $^{1}/_{3}$ of its original thickness. The gill-rakers, 42 in number, may be counted on the first branchial arch. They are

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[a] According to McCOY'S measurements the length of the head is greater than the depth of the body; but the figures show that he took the length of the head when the mouth was protruded.

[b] The greatest depth of the body in % of the distance between the head and the vent measures, according to published statements,

in the specimen from North Fjord (1855 — Bergen Museum)	24·9
,, ,, ,, ,, Langesund (1822 — Christiania Museum)	26·5
,, ,, ,, ,, Grovie (1844, see RICHARDSON, Suppl. to YARR., *Brit. Fish.*)	26·1
,, ,, ,, ,, the Cape of Good Hope (1868, see LAYARD, Proc. Zool. Soc.)	25·9

fairly long, the longest ones measuring more than 2 cm., and entirely different from those of the preceding genus. Neither of the ventral rays is present, but of the left pectoral fin there remain the basal parts of 13 rays.

The distance between the base of the first dorsal ray and the base of the ventral fin is 277 mm.

The distance between the base of the first dorsal ray and the vent is 1,455 mm.

The distance between the anterior end of the base of the pectoral fin and the base of the ventral fin is 66 mm.

The distance between the anterior end of the base of the pectoral fin and the vent is 1,320 mm.

The last measurement suggests that the length of the living fish was about 38 dm.

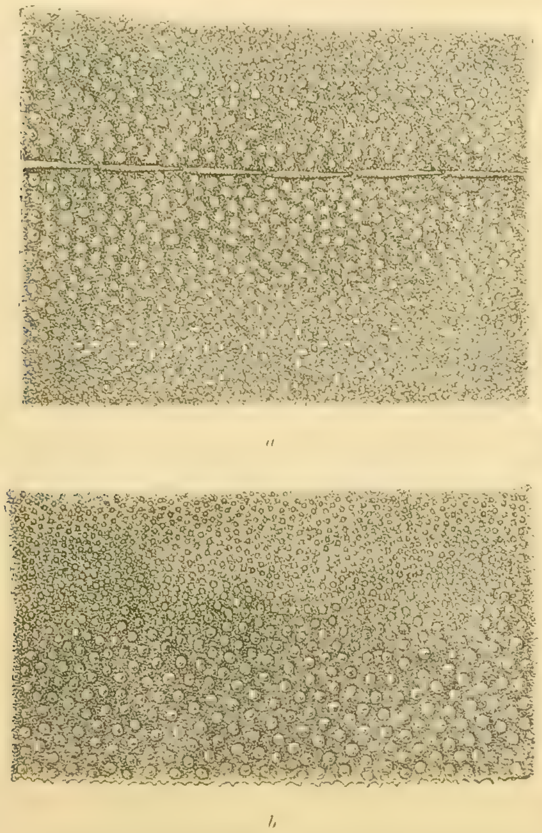

Fig. 88. *Regalecus glesne*, portions of the skin of the specimen from Burholm, *a:* with a part of the lateral line, where it traverses one of the carinae on the side of the body; *b:* a part of the ventral margin. Natural size.

The King of the Herrings lives in very deep water, its species being perhaps identical in all the oceans; but of its usual manner of life we know nothing. Occasionally it appears at the surface, and in the superstitious imagination of the sailor takes the form of "the great Sea-serpent."[a] Hancock and Embleton describe the capture by three fishermen from Cullercoats in Northumberland, not far from Newcastle, on the 26th of March, 1849, of the specimen afterwards examined by these writers. The fishermen found it about 6 miles from shore and in from 20 to 30 fathoms of water, when they were leaving their fishing-station to return home. When they came upon it, the fish was lying at full length on its side at the surface; but at their approach it "righted itself, and came with a gentle, lateral, undulating motion towards them, showing its crest and a small portion of the head occasionally above water: when it came alongside, one of them struck it with his picket — a hook attached to the end of a small stick, and used in landing their fish; on this it made off with a vigorous and vertical undulating motion, and disappeared as quick as lightning under the surface. In a short time it reappeared at a small distance, and pulling up to it they found it again lying on its side: they plied the picket a second time and struck it a little behind the head; the picket again tore through the tender flesh by a violent effort of the fish, which escaped once more, but with diminished vigour; on the boat coming a third time alongside, the two young men putting their arms round the fish lifted it into the boat. Signs of life remained for some time after the fish was captured, but no doubt it was in a dying or very sickly state when first discovered."

According to the account of these fishermen the whole body of the fish was of a silvery, iridescent ground-colour, as brilliant as that of the common Herring, but with a decided dash of blue. In the open air, however, the colour soon fades, and the silvery gloss vanishes at the slightest touch. It is also probable that the colour of the dark brown, longitudinal stripes on the lateral ridges of the body is due to injury. The black transverse bands which cross the sides obliquely in a downward and backward direction, as well as the scattered black spots, disappear soon after death, leaving scarcely a visible trace behind, according to Wright[b], after the lapse of a day or two. Eventually the fish becomes darker and darker, and in the process of drying turns quite black, as is the case with Lindroth's specimen in the Royal Museum.

We are still ignorant of the exact shape of the occipital fin. Hancock and Embleton were told by their informants that the rays were like peacocks feathers. Naalsöe's drawing as reproduced by Lütken (l. c.)

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[a] The tales of the great Sea-serpent may probably be explained by a variety of different causes — tumbling dolphins, enormous cuttle-fish, specimens of *Selache* (Basking Shark) floating and resting at the surface, or even floating wreckage. But in the cases where the Sea-serpent appears with crest erect, the explanation seems to lie in the appearance and death-struggles of the King of the Herrings at the surface of the ocean.

[b] Nat. Hist. Trans. North., Durham, vol. V (1877), p. 341.

and also LAYARD's figure of the *Regalecus* from the Cape of Good Hope[a] render it probable that the high crest or mane of "the great Sea-serpent" is formed in the manner shown in VALENCIENNES's figure of *Regalecus gladius*, and consists of two parts, the one being formed by the first five rays (the first ray being the longest and thickest according to WRIGHT (l. c.) and ending in a fine, filiform tip, the other four slender and gradually decreasing in length). The second part consists of from 9 to 12 rays, the first of which is the longest, the others gradually diminishing in length, and all of them with foliate tips or, according to DAY, with the membrane behind the tip of each ray elongated into a filament which in shape resembles the dorsal filaments of the Dory, but is shorter than they. All the latter rays are probably united, at the base at least, to each other as well as to the true dorsal fin.

In the singular, long rays of the ventral fins, which remind us of the juvenile stages of *Trachypterus*, the foliate, membranous extension of the tip, according to NAALSÖE and COLLETT, is triangular and trilobate. This description also agrees closely with LAYARD's figure, according to which, as in VALENCIENNES's *Regalecus gladius*, there also appears a triangular dermal flap on the inner side of the ray, the distance between this flap and the base of the ray being twice that between it and the tip of the latter. In spite of the variation to which the length of the ventral rays is apparently subject, their tip, to judge by LINDROTH's specimen, always extends at least beyond the vent.

The length of the pectoral fins, according to HANCOCK and EMBLETON as well as WRIGHT, is a third greater than the diameter of the eye, but according to LINDROTH, equal to the latter and also to the thickness of the head behind the eyes[b]. According to HANCOCK and EMBLETON these fins are colourless[c].

The average distance between the vent and the tip of the snout in Atlantic specimens is rather more than 40 % of the length of the body, and the distance between the former and the middle of the hind margin of the gill-cover (behind the head) is somewhat more than 34 % of the length of the body; but into these measurements there enters a factor in most cases obscure, *viz.* the total length of the body. The King of the Herrings has not always been found under so favourable circumstances as in the above cases, where it has been possible to lift the entire fish into a boat or, as in the case of LINDROTH's specimen from Hitteren, to discover it soon after it has come ashore. The fish has generally been found dead and in a damaged condition among the breakers on the beach. From the structure of the end of the tail in the best-preserved specimens it appears that the tail is almost invariably broken during life, but heals again, leaving the surface of the fracture in a fairly characteristic S-curve, as has been the case in the specimens of HANCOCK and EMBLETON, LINDROTH and others. Furthermore, as COLLETT has fully demonstrated, this fracture may recur repeatedly, or, at all events, a larger part than usual may be broken off, in which case it is of course still more difficult to arrive at the total length of the body[d].

The remark we have made with regard to the shape of the body during life in the preceding genus, also applies to *Regalecus*. It is undoubtedly much more terete than in the specimens preserved in spirits as we see them in the museums. WRIGHT found the greatest thickness of the body in his specimen to be about 34$^1/_2$ % of the greatest depth. According to LINDROTH the corresponding proportion in the Hitteren specimen was 25 %, and in the Crovie specimen, according to RICHARDSON, 23 %. In the Burholm specimen I find the greatest thickness of the body to be only slightly more than 12 % of the greatest depth. A variation so considerable — from $^1/_3$ to $^1/_8$ — can be explained only by the loose structure of the body and the different extent to which the various specimens have shrunk. The dorsal edge is thin and sharp, the greatest thickness being situated in the lowest third of the body.

In Norway, according to COLLETT, 13 specimens of the King of the Herrings have been found at different spots along the entire coast line, between 1740 and 1883. Most of them, however, were found off the south coast, during the spring Herring-fishery. The Museum of Copenhagen possesses a specimen from the Faroe Islands. From Scotland and the north-east of England 20 specimens are known, found between the middle of the last century and the present time. At the end of the last century one specimen was found on the Cornish coast.

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[a] Proc. Zool. Soc. London 1868, p. 320.

[b] In the Australian *Regalecus*, according to McCOY, the length of the pectoral fins is $^1/_3$ less than the diameter of the eye, but equal to the length of their base, just as in the Atlantic species, according to LINDROTH and WRIGHT.

[c] White in the Australian *Regalecus*, according to McCOY.

[d] In the Australian specimen described by McCOY the end of the tail was almost pointed, but still imperfect, and in this respect this specimen is the most nearly perfect of all. Of the position of the vent, however, McCOY does not say a single word.

All the Atlantic specimens that have been examined, were females. This was also the sex of the only specimen yet found in Sweden, the above-mentioned specimen from Burholm, off Koster in the north of Bohuslän. In this specimen there was not the least trace of food in the stomach or the intestinal canal. In the specimen examined by Hancock and Embleton, the cæcal prolongation of the bottom of the stomach contained a few partially-digested ova.

If it is really the case, as has been assumed, that the females approach the banks and coasts in order to deposit their eggs, and thus trespass upon regions where the pressure is too slight to suit them, still it is remarkable that the males do not fall victims to the same misfortune just as often. We may, therefore, equally well accept the other assumption made in order to account for the appearance of these fishes at the surface, that they have been driven by disease or some enemy — perhaps in pursuit of some prey — beyond the limits of the pressure necessary to their existence.

The eggs of these fishes are small and fine as those of the Cod, and are contained in enormous numbers in the ovaries, which may be a metre long and an inch broad. As yet, however, we can scarcely decide with certainty the time of year at which the eggs are ripe. A specimen about 3 metres long, which was taken on the coast of Yorkshire on the 23rd of April, is stated to have had ripe roe; but even in the month of August the Hitteren specimen contained "eggs fine as a grain of sand." The spawning-season is thus doubtful, but is supposed by Collett to occur during the summer or autumn months. It is a matter of doubt, however, whether the deep-sea fishes are in this respect subject to the influence of the seasons.

"The flesh is white and fine," say Hancock and Embleton. "The smell of the fish," says Lindroth, "was almost like that of raw fish in general, but when the skin was scraped clean of flesh, the fibres of the latter dissolved into mucus and water, which soon became rotten. The flavour of the flesh did not seem especially good, but somewhat offensive, this being probably due to the repugnant smell diffused during the process of cleaning the skin. When boiled, the flesh was more firm and compact, like that of the Eel, but entirely destitute of fat and almost tough. The dogs refused to eat it, whether raw or boiled."

MUGILIFORMES.

Body terete or compressed like that of the Perches. Two dorsal fins, separate from each other[a], *the first short and containing few or weak spinous rays, the second in form and position analogous to the anal fin. Ventral fins of typical structure* ($^1/_5$), *but abdominal.*

According to Günther's[b] establishment and definition of this series of families, it includes fishes of very different habits. Some of them, the family *Sphyrænidæ*, belong to the most pronounced fishes of prey, with large gape and huge jaw-teeth, and comprise the *barracudas* of the tropical seas[c], which even venture to attack persons bathing. Others, on the contrary, the *Atherinidæ, Tetragonuridæ* and *Mugilidæ*, are feebly armed or even without true jaw-teeth, and live only on weak victims or decomposing substances. The former were, therefore, ranged both by Cuvier[d] and Cope[e] among the Perches, in spite of the fact that they have lost the immediate connexion between the ventral fins and the shoulder-girdle. The latter, even by Cuvier[f], were ranged side by side with each other and next to the *Ophiocephalidæ*, air-breathing, fresh-water fishes of the Indian region, together with which family they were united by COPE[a] into a group, under the name of *Percesoces*. GILL[b], on the other hand, excluded the *Ophiocephalidæ* from this group. These varying opinions are also dependent on the different importance set on the structure of the dorsal fin, a character which unites the Barracudas to the Gray Mullets (*Mugilidæ*), but separates from them, not only the *Tetragonuridæ*, but, still more distinctly, the *Ophiocephalidæ*. In the case of these last fishes the ventral fins are also thoracic, and the only close resemblance they possess to the Gray Mullets, lies apparently in the scaly covering of the head.

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[a] In this respect *Tetragonurus* is exceptional.

[b] *Cat. Brit. Mus., Fish., Syst. Syn. Acanth. Fishes*, p. VIII; *Introd. Study of Fish.*, p. 499; *Handb. Ichth.*, p. 355.

[c] One species, *Sphyræna spet* or *vulgaris*, belongs to the Mediterranean and the Atlantic outside it, and is only slightly, if at all, different from one of the North American species.

[d] *Règne Animal*, nouv. éd., tome II, p. 156.

[e] Trans. Amer. Philos. Soc., Philad., new. ser., vol. XIV, p. 472.

[f] L. c., p. 230.

The Scandinavian fauna contains only one of these families.

FAM. **MUGILIDÆ.**

Anterior part of the body broad at the dorsal side and more or less depressed, at the ventral side more compressed, but terete. First dorsal fin with 4 (extremely seldom 5) strong spinous rays: second dorsal, as well as the anal[c]*, with 8 or 9 (seldom 7 or 10) branched rays behind the simple, but articulated ray at the beginning of the former fin and the three spinous rays*[d] *at the beginning of the latter. Mouth transversely set, narrow or only slightly cleft laterally, and furnished with small or setiform jaw-teeth. Scales cycloid*[e]*, imbricate, fairly large and on the head extending forward over the forehead; on each side of the base of the first dorsal fin and often at the upper angle of the pectoral fin, as well as at the outer angle of the ventral fin, distinct, axillary scales with a lobate elongation. No distinct, continuous lateral line, but most of the scales pierced or incised to receive the opening ducts of the system of the lateral line. Air-bladder large. Branchial arches all present. Pseudobranchiæ well-developed. Gill-openings large. Branchiostegal rays 5 or 6. Pyloric appendages few. Pyloric part of the stomach muscular, sometimes like a bird's craw. Intestine long and arranged in numerous coils. Peritoneum black. Vertebræ 24*[f]*, the anterior abdominal vertebræ with well-developed or even strong transverse and spinous processes. Basal bones of the pectoral fins short and flat. Branched rays of the caudal fin 12.*

The Mugiloid family, which was recognised as distinct even by CUVIER (l. c.), contains extremely similar species, the determination of which has been a point both difficult and debatable. The number of the species cannot, therefore, be stated with any positiveness; but about a hundred species have been named. These were distributed by VALENCIENNES[g] among 4 genera, by GÜNTHER[h] among three and by the American writers GILL[i] and JORDAN and SWAIN[j] among six. Only one of these genera, the most typical and containing the most numerous species of the whole family occurs within the limits of the Scandinavian fauna. The geographical range of the rest of the family embraces all the tropical and temperate seas; and many of the species are recognised visitors of brackish or even fresh water. These visits are not paid, however, as in the case of the true Anadromous fishes, for the purpose of spawning, but in search of food. The usual food of these fishes consists of various minute animals[k] and decomposing substances which they search for at the bottom, rooting up the mud or sand or among the seaweed. The buccal and pharyngeal apparatus are also specially adopted to this purpose. The snout, which is usually very short, is furnished on each side, in front of the eye, with a preorbital bone, serrated at the posterior and outer (lower) margins, and performing its rooting function in the search for food. The teeth of the mouth are either weak or replaced by flexible bristles, enamelled only at the tip. These bristles, however, are not mere dermal growths, but originate from the dental margins of the intermaxillary bones themselves and of the lower jaw, which margins seem coated, as it were, with a layer of dentine, broken into closely set bristles. In the upper jaw, which is furnished with a fleshy and often considerably tumid lip above the intermaxillary bones, these bristles project beyond the labial margin; but the lower jaw has a sharp edge, turned outwards and generally without any external traces of bristles. At the tip (above the symphysis) the lower jaw is furnished with two hard protuberances, which fit into a corresponding incision at the middle of the margin of the upper jaw. The mouth is protrusile, though not to any great extent, the nasal processes of the intermaxillary bones being broad, but short. This is the nature of the apparatus of the jaws in the more typical Mugiloids; and everything that is conveyed into the mouth by means of this apparatus, including a great number of indigestible substances mixed with the food, undergoes in the pharynx a preliminary process of mastication and filtration. The pharynx is constructed especially with a view to this purpose. The skin of the palate and tongue is closely set with tubercles and often even with small teeth; and the pharyngeal bones form the framework of thick swellings which obstruct the pharyngeal cavity and the opening of the œsophagus. The upper pharyngeal bones are broad and curved into a slightly patelliform shape, with the convex side downwards, pointed in front, but more rounded behind. They rest on a soft, but thick layer of fat on the under surface of the skull, and are covered by a skin thickly set with tubercles and partly, at the inner margin, with small teeth. Between and behind the upper pharyngeals there also lies on each side a swelling with a soft, adipose base; but at the middle of the roof of the palate there runs a groove into which the lower pharyngeal bones and the base of the tongue (the copular row of the hyoid bone) fit. The gill-rakers are comparatively short, but dense and fine. Here the mouthful of different substances is chewed, and the larger pieces of the indigestible part rejected. The inside of the œsophagus is furnished with long filaments, amongst which a copious secretion of mucus is collected. The stomach proper is comparatively small and thin-walled, with the bottom in the form of a short blind sac; but the pyloric part, which is distinctly separated therefrom, in the typical Mugiloids is thick-walled and furnished with a strong muscular covering, and calls to mind the craw of a bird. The pyloric appendages are few, generally 6—8 and sometimes only 2. The intestine is extraordinarily long and lies in numerous coils, sometimes as many as 20. A digestive canal of this length is rare among the class of fishes[a]. The whole of the digestive apparatus bestows upon the Gray Mullets a great capability of extracting nourishment from the substances of which their food is composed; and they also belong to the fattest, most active and most prolific of all fishes.

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[a] L. c., p. 456.

[b] Smithson. Misc. Coll., No. 247, p. 13.

[c] Sometimes (in exotic forms) the anal fin contains 11 or 12 branched rays.

[d] The third of these rays may sometimes, however, be branched.

[e] In most cases, however, the scales are rough (granulated) at the surface, and in some Indian fresh-water species of the genus *Mugil*, according to DAY, this granulation may pass into marginal spines, the scales thus becoming ctenoid.

[f] From 24 to 26, according to DAY.

[g] CUV., VAL., *Hist. Nat. Poiss.*, tome XI, p. 1: *Mugil*, *Cestræus*, *Dajaus*, *Nestis*.

[h] *Cat. Brit. Mus., Fish.*, vol. III, p. 409: *Mugil*, *Agonostoma* (= *Cestræus* + *Dajaus*, + *Nestis*), *Myxus*.

[i] Proc. Acad. Nat. Sc. Philad. 1863, p. 169: *Chænomugil*, *Rhinomugil*.

[j] Proc. U. S. Nat. Mus., vol. VII, p. 261: *Querimana*.

[k] In the stomach of *Mugil chelo* THOMPSON (*Nat. Hist. Irel.*, vol. IV, p. 103) found chiefly small shellfish.

The skeleton is in several points worthy of notice. The broad top of the cranium is convex and smooth, without any projecting osseous ridges, its great breadth being due to the space required by the pharyngeal cavity to contain the masticatory apparatus described above. The ridges which issue in a backward direction from the upper occipital bone, the mastoid bone (*epoticum*), the pterotic bone and even the styloid bone (*opisthoticum*), on the other hand, are all the longer and sometimes of an extraordinary length. The first-mentioned ridge (*crista ossis occipitis*) advances above the extraordinarily long lateral parts of the occipital bone, and meets the neural spine of the first vertebra. The mastoid bone sends out a foliate, somewhat bent, osseous process, which may attain a length almost half that of the head, and is continued in the flesh to a point vertically above the second vertebra. This process may well be regarded as an ossification of the muscles. To the outer side of the base of this process is attached the upper prong of the posttemporal bone, while the shorter lower prong joins the process of the styloid bone. The posterior process of the squamosal bone is shorter than that of the mastoid bone, though it may extend to a line with the beginning of the last third of the gill-cover, but stronger in proportion and of a pointed, triangular shape. The upper neural spines and transverse processes of the first six vertebræ are also well-developed, the former being extended into disks in the longitudinal direction of the body; and as the corresponding interspinal bones are equally broad[b], a continuous osseous roof is thus formed above the anterior part of the spinal column, back to the insertion of the first dorsal fin. All this singular development of bone gives increased firmness to the front part of the body, and strengthens the points of origin of the upper lateral muscles of the body and the marginal muscles of the back. The same strength is given to the lateral muscles of the lower part of the body and those of the pectoral fins by the deeply incavated hind margin of the clavicular bone. This bone is also furnished on the inner side with a hamate process. Each of the pelvic bones is suspended posteriorly by a ligament from the lower postclavicular bone and anteriorly from the lower end of the clavicular bone. The anterior branchiostegal rays are almost filiform, the posterior distally extended and sword-like. The large opercula are longitudinally arched at the top, and thus serve both as the roof and outer wall of the gill-cavity. They are quadrilateral in shape, but the lower posterior corner is obliquely rounded. The preoperculum is more or less nearly rectangular, with the anterior margin incavated. Both the suboperculum and the interoperculum are well-developed and fairly uniform in breadth, the latter being, however, as usual narrower in front. As a rule too, they are covered with scales, as well as, in many cases, the posterior (angular) part of the under surface of the branches of the lower jaw. The interopercula generally, and the branches of the lower jaw sometimes, meet or even cross each other to a greater or less extent under the throat. The branches of the lower jaw, however, generally leave a naked chin-space[a] between them, the size and shape of which may sometimes be of use as a specific distinction. In cases where the interopercula do not quite touch, this chin-surface is continued backwards by the bare part of the branchiostegal membranes, which cross each other anteriorly, under the isthmus.

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[a] We find the nearest approach in this respect to the Gray Mullets in certain of the Carps and Chætodonts.

[b] See AGASSIZ, *Poiss. Foss.*, Atl., tome V, tab. *F*, fig. 2.

The shape of the preorbital bone too, is often of importance in the determination of the species. The outer, externally visible part is square; but in its entirety the bone is rather triangular or polygonal, with the posterior and lower (anterior) margins sharply serrated. In front of and below this bone, and often, when the mouth is closed, entirely concealed by it, lies the singularly bent and twisted maxillary bone. The articular process of the latter is S-shaped and directed at a right angle inwards, and is furnished posteriorly with a long, convex, articular surface, turned towards the point of the ethmoid bone and the top of the head of the vomer, which projects in front of the latter, and anteriorly, further in, with a similar articular surface, turned towards the nasal process of the intermaxillary bones. The shaft of the maxillary bone is also bent and terete or, at all events, uniformly narrow, with the hind part more or less crooked; and on its inner side we often find a wand-shaped process, pointing in a backward (upward) direction. The intermaxillary bones are short and deep. The mandible is so twisted that the dental part is horizontal, with the dental margin turned outwards and forwards and the posterior articular (angular) part inwards and backwards.

As we can easily see from the above description, the Mugiloids have several points of resemblance to the Cyprinoids; but the most striking external resemblance, the broad dorsal side of the forepart in conjunction with the high position of the pectoral fins, guides us towards the *Scombresocidæ* and, nearest of all, to the Flying-fish. Both the comparisons involve soft-rayed fishes, and gain still further significance by the abdominal position of the ventral fins. Among the Acanthopterygians the Mugiloids and Atherines occupy a somewhat isolated position.

GENUS **MUGIL.**

No teeth proper: mobile, setiform teeth, externally visible, as a rule, only in the upper jaw; margin of the mandible sharp: mouth transversely placed, and its breadth greater than its length. Nostrils set on the upper side of the short and blunt snout, the anterior being small and round, the posterior oblong and transverse. Pyloric part of the stomach highly muscular.

By this limitation the genus *Mugil* is exclusively reserved for the most typical forms among the Gray Mullets. In spite of this, the genus contains by far the greater part of the family, perhaps some seventy species, though it is highly probable that many of them are species only in name.

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[a] *The space at the chin, between the mandibles:* GÜNTHER; *espace jugulaire:* MOREAU.

From olden times the genus has been well known in Mediterranean countries. ARISTOTLE, who calls the genus *κεστρεὺς*, gives the names of perhaps four or five species, at least two or three, viz. *χελὼν* (*πρόσγειος*), *μύξων* (*περαίας*) and *κέφαλος*[a]. The Romans called the genus *Mugil*[b], and it was under this name that it was introduced by ARTEDI[c] into modern ichthyology.

The Gray Mullets have gained great prominence from the excellent flavour of their flesh and their peculiar manner of life. They are gregarious, and we have many telling observations of their love of society. In search of food they approach the coast in shoals, especially where the bottom is dead, i. e. full of decomposing materials, for it is here they find food in greatest abundance, or they may even ascend the rivers. In the River Loire they have been caught above Saumur[d], and they formerly entered the River Somme in May, says BLANCHARD[e], in such enormous shoals that the river for days was full of them; but since the opening of the canal between Abbeville and the sea, they have deserted this river, according to MARCOTTE. These migrations to brackish or fresh water have given rise, in many places, to important fisheries for the Gray Mullets. "Although Mullets," says BROWN-GOODE[f], "are abundant almost everywhere, it is probable that no stretches of seacoast in the world are so bountifully supplied with them as those of our own Southern Atlantic and Gulf states, with their broad margin of partially or entirely landlocked brackish water and the numerous estuaries and broad river mouths." Without any other means of defence, and pursued as they are, not only by man, but by numbers of fishes of prey and seabirds, they escape by the extraordinary quickness and strength of their movements. They have always been notorious for their powers of leaping over or forcing their way under the nets and seines with which the fishermen have barred their path or surrounded them. The Neapolitan fishermen described to CETTI[g] four kinds of Gray Mullets: "The first, *Cefalo*, is the largest and has the largest head. The second, *Ozzone*, with more pointed head, takes only one jump when it leaps. The third *Tumula* or *Liza*, forms a circle with its tail when it leaps, the head being the centre of the circle. The fourth, *Concadita*, attains a weight of more than two pounds. When it leaps out of the water, it skims the surface like the small flat stones thrown by children in the game of 'ducks and drakes'." "At Mevagissey," says DAY[h], "a shoal entered the harbour, and having been perceived, the entrance was at once barred by nets. The fish first tried to jump over, but a net was raised so as to bar that route. The water was very clear, and the fish were seen to swim round and round, to try to find an exit. Next they attempted to get under the foot rope: at last one made a push, but became meshed. When this was done, another came and laid (*sic*) beside it, and nothing could drive it away. In short, all escaped but these two."

The method resorted to by the Gray Mullets of seeking escape by jumping over the net is instinctive, and this instinct, like others, is the outcome of hereditary and growing habit. "Even Mullets of extremely small size," writes COUCH[i], "have been seen to throw themselves, head or tail foremost, over the head line of a net, where it would have seemed much easier for them to have passed through a mesh."

There are many instances related of the co-operation of individuals in a shoal, in the attempt to escape from their prison; and when only one fish has shown the way, the others instantly follow. The same remark also applies, however, to other fishes when in shoals; and it is hardly probable that the Mullets possess the power of calculating or estimating the nature of the obstruction in a higher degree than many other fishes, for this habit of leaping over the obstacle may mislead them no less than other fishes. "In the port of Lose, in Cornwall," says Couch, "there is a saltwater mill pool of thirteen acres that is enclosed on the side of the river by an embankment, and into which the tide flows through flood-gates that afford a ready passage for fish to the space within. When the tide begins to ebb the gates close of themselves, but even before this has happened the Mullets which have entered have been known to pass along the enclosed circuit within the bank, as if seeking the means of deliverance, and, finding no outlet, they have thrown themselves on the bank on the side to their own destruction."

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[a] The zoological system of ARISTOTLE must naturally not be judged by the requirements of modern times. In some passages of his writings *κέφαλος* is a species of *κεστρεὺς*, in other passages *χελὼν* and *μύξων* are species of *κέφαλος*, the former being *πρόσγειος*, i. e. a shore-fish, and the latter *περαίας*, i. e. a form living outside the archipelago or far out at sea.

[b] CHARLETON derives this word from *mucus* (for the fish, according to ARISTOTLE, eats its own slime): ISIDORUS regards it as a contraction of *multum agilis*.

[c] *Gen. Pisc.*, p. 32. In the Appendix to *Syn. Pisc.* ARTEDI adopted a genus *Chelon*, with species *chelo* and *myxo*, but only on the authority of ARISTOTLE, GAZA, RONDELET and GESNER.

[d] DUHAMEL, *Traité des pêches*. II part., VI sect., p. 144.

[e] *Poiss. d'eau douce de la France*. p. 251.

[f] *Fisher. a. Fisher. Ind. U. S.*, Sect. I, p. 450.

[g] *Naturg. v. Sardinien*, Th. 3 (Transl., Leipsic 1784), p. 203.

[h] *Fishes of Great Britain and Ireland*, vol. I, p. 229.

[i] *Fish. Brit. Isl.*, vol. III, p. 12.

Aristotle quotes the Gray Mullets as the only representatives of their class "that refused to eat flesh;" and after his time these fishes were generally famed, and by Ovid and Oppian celebrated in song, for their peaceable disposition and other social virtues, as well as for their sagacity in avoiding any lure. For all this they are by no means vegetarians, and destroy quite as many lives as other fishes. "From a single stomach of the Thicklipped Gray Mullet," says Thompson (l. c.), "I have obtained what would fill a large-sized breakfast cup of the following species of bivalve and univalve mollusca (which had been taken alive) — *Mytilus edulis*, *Modiola papuana* (of these very small specimens), *Kellia rubra*, *Skenea depressa*, *Littorina retusa*, *Rissoa labiosa* and *R. parva*, *Serpulæ* and *Miliolæ*. Of these mollusca, specimens of *Rissoa labiosa*, three lines in length, were the largest, and the *Kellia rubra*, from the smallest size to its maximum of little more than a line diameter, the most abundant. In the profusion of specimens it affords, the stomach of one of these mullets is quite a store house to a conchologist. In addition to these were various species of minute crustacea. The only inanimate matter that appeared, were fragments of *Zostera marina* and *Confervæ*, which were probably taken into the stomach on account of the adhering mollusca." It is probably for this same reason that the Gray Mullets follow vessels into harbour, and haunt the algæ attached to the vessel's bottom. At certain seasons of the year at least, the Gray Mullets freely take a bait. In Blanchère's work[a] Savigny gives a description of this fishery, as it is carried on on the French side of the Channel, near Dieppe. The bait is composed chiefly of Annelids, Nereids of the kind we may often see crawling among the roots of seaweed or on oyster-shells etc. When the shoal of Mullets approaches along the coast or roves outside the quays or flood-gates of the harbours, in August and September in particular, a busy fishery is pursued on land and in boats. The active fishes are often taken without biting, the hook catching in the belly or tail or some other part of the body. The fishermen call these catches *stolen* fish (*volé*), and know the bite by its uncommon strength, at least three times that of an ordinary bite. These occurrences explain the old myth that the Mullet first takes the precaution of striking the bait with its tail (Ovid). In other places a bait of dough or something similar is used.

The most usual and most productive fishery, however, is carried on with seine and net. The cautiousness of the Mullets and their leaping-powers necessitate the use of special tackle, as for instance trammels, nets with a double head-line or back floating at the surface etc. In some places it is customary to spread straw in front of the seine, it being supposed that the fish dare not leap between the straws.

The largest catches of Mullets are made, to the best of our knowledge, in the Mediterranean and the Gulf of Mexico and on the Atlantic coast of Florida. In recent times it has been supposed[b] that the species which is commonest on both sides of America (the *Mugil albula* of Linnæus), is identical with the species most important in the Mediterranean, *Mugil cephalus*, which is foreign to the Scandinavian fauna, but of which we have the fullest information. On the east coast of Florida, according to Brown-Goode (l. c.), we may distinguish between "three periods of schooling or separate runs of Mullet. The "June Mullet" average about five to the pound; the "Fat Mullet," which are taken from August 20 to October 1, weigh about two pounds; these have, the fishermen say, a "roe of fat" on each side as thick as a man's thumb. The "Roe Mullet" weigh about two and a half pounds, and are caught in November and until Christmas. Between the seasons of the "Fat Mullet" and "Roe Mullet" there is an intermission of two or three weeks in the fishing." Fishes of a greater weight than 3 kgm, are exceptional, though specimens 58 cm. long and 5 kgm. in weight are on record. In this genus, however, the largest fishes are by no means the most highly esteemed.

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[a] *Nouv. Dict. Gen. d. Pêches*, article *Mulet*.

[b] Jordan and Swain, Proc. U. S. Nat. Mus., vol. VII (1884), p. 263.

The Gray Mullets belong to the most prolific of fishes[a]. They are said to spawn in comparatively shallow water, where the bottom is weedy, sandy, muddy or strewn with shells, and, according to STEARN's observations in the Gulf of Mexico, at spots where the water changes from salt to fresh with the ebb of the tide, at a temperature of from 70° to 75° Fahr. Fat and delicious as it is before the spawning-season, the Gray Mullet is afterwards thin, lean and unfit for food. In the countries bordering on the Mediterranean a caviare of great reputation, known as *botargo*, is prepared from the ovaries. From the age of 3 to 5 months, according to STEARN, the Gray Mullet is from 1 to $2^1/_2$ in. long, and is found in great quantities near shore. During the first year it is said to grow to a length of about 8 in. and during the second to 12 or 13 in., when it weighs about a pound and a quarter. When it returns to shore from its wanderings out at sea, it changes colour. In the open sea the back is glossy blue, in the inlets light brown, and in fresh water of a dark brown colour.

In large aquaria the Gray Mullets may be kept alive without difficulty for lengthy periods. There are instances to show that these fishes, where confined to fresh water, may even become fatter than in the open sea[b]. The Frenchman VIDAL[c] asserts that he has cultivated or rather reared thousands of Mullets in ponds. CAREW, the Cornish historian, according to COUCH[d], had formed a pond on a branch of the Tamar, in which Mullets were fed at regular periods, and they were drawn together to the appointed spot at the sound made by the chopping of their food.

GÜNTHER divided the genus *Mugil* — if we now follow GILL and separate from it *Chænomugil* and *Rhinomugil* — into three groups, corresponding to CUVIER's three chief species, *Mugil cephalus*, *capito* and *chelo*. The first group is marked by the well-developed adipose membrane over the eyes, both in front of and behind the pupil, and the slight tumidity of the upper lip; the second is without the adipose membrane, but also without the swollen upper lip; and the third is distinguished by the prominent tumidity of the upper lip. The first group, which is wanting in the Scandinavian fauna, is spread both over the Old and New Worlds, the other two belong exclusively to the Eastern Hemisphere. Within the limits of the Scandinavian fauna three species have been found, which may be most easily distinguished as follows:

A: Height (thickness) of the upper lip at least about 16 % of the length of the head behind the eyes .... *Mugil chelo.*
B: Height of the upper lip at most about $12^1/_2$ % of the length of the head behind the eyes:
  a: Length of the ventral fins at most about 70 % of that of the pectoral fins ...... *Mugil auratus.*
  b: Length of the ventral fins at least about 80 % of that of the pectoral fins ...... *Mugil capito.*

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[a] OLSEN, *Piscat. Atl.*, pl. 30, estimates the number of the eggs in a female specimen of *Mugil capito* at thirteen million, an estimate which is probably too high, for the eggs, according to RAFFAELE (Mitth. Zool. Stat. Neap. Bd. 8, p. 77), are 1 mm. in diameter when the embryo has begun to develop, as was the case with the eggs he found during the summer months. They are said to develop while floating at the surface.

[b] ARNOLD, Proc. Zool. Soc. London 1831, p. 126 and YARR., *Brit. Fish.*, ed. 2, vol. I, p. 239.

[c] Bull. Soc. Zool. d'Acclimat., ser. 2, tome IV (1867), p. 190. According to this writer it is possible, with the usual precautions, to keep from 600 to 800 Mullets, between 25 and 40 cm. in length, in a pond of an area of 25–30 square metres and a depth of about $1^1/_2$ metres.

[d] *Fish. Brit. Isl.*, vol. III, p. 13.

THE THICK-LIPPED GRAY MULLET.

MUGIL CHELO.

Plate XV, fig. 11.

Adipose membrane round the eyes only slightly developed. Upper lip swollen and thick, its height in front, in specimens from 27 to 45 cm. long, measuring at least about $^{1}/_{10}$ (9·7[a]—11·2 %) of the total length of the head, 18[b] to 21 % of the length of the head behind the eyes, 30[c] to 33 % of the length of the snout, 26 to 32 % of the breadth of the mouth or 27[d] to 33 % of the length of the lower jaw. Upper lip, in full-grown specimens at least, furnished with two or more transverse rows of tubercles on the lower part. Length of the snout (distance between the eyes and the middle of the upper lip when drawn back) distinctly more than half (59—62$^{1}/_{2}$ %) of the length of the head behind the eyes, which, in specimens of the above size, measures at most $^{1}/_{9}$ (10·8—11·2 %) of the length of the body, 54 % of the total length of the head, 55 % of the greatest depth of the body or 25$^{1}/_{2}$ % of the distance between the first dorsal fin and the tip of the snout. Length of the lower jaw more than 62 % (62·3—69 %) of the length of the head behind the eyes, and the breadth of the mouth more than 63 % (63·3—71·1 %) of the latter. Breadth of the interorbital space at least about 80 % (79—90 %) of the length of the head behind the eyes. Length of the head as a rule distinctly less than 24 % (22—23 %) of the length of the body minus the caudal fin or than 49 % (45—48·3 %) of the distance between the first dorsal fin and the tip of the snout. Least depth of the tail more than 85 % of the length of the head behind the eyes and at least about 61 % (60·7—66 %) of the length of the pectoral fins, which is at most 16 % of the length of the body or 48 % of the distance between the ventral fins and the tip of the snout. Base of the second dorsal fin more than $^{3}/_{4}$ (80—90 %) of the base of the anal fin, than $^{2}/_{3}$ (68—76 %) of the length of the head behind the eyes or than 36 % (37—40 %) of the total length of the head. Length of the ventral fins about 80 % (71—86$^{1}/_{2}$ %) of that of the pectoral fins. Middle groove of the roof of the pharynx continued forward in the roof of the palate, where it is bounded on each side by a longitudinal, rounded elevation. The tongue, which is highly and sharply carinated, fits into this palatine groove. Hind extremity of the preorbital bone obliquely truncate, with the lower corner rounded. Hind (lower) extremity of the maxillary bones externally visible, even when the mouth is closed. Chin-space usually small and narrow, its breadth being less than half that of either of the branches of the lower jaw at the hind extremity.

R. br. 6: *D.* 4,9 (2+7 l. 1+8): *A.* $^{3}/_{9}$ l. $^{3}/_{8}$; *P.* 1 l. 2+15 l. 16: *V.* $^{1}/_{5}$: *C.* $x+12+x$; Squ. lin. lat. 43—47; lin. tr. 13—15.

Syn. *Chelon*, RONDEL., *De Pisc.*, lib. IX, cap. V; cett. vide ARTEDI, *Syn. Pisc.*, App., p. 118.

Mugil cephalus, var. *B*, DELAROCHE, *Ann. Mus. D'Hist. Nat.*, tome XIII, pp. 318 et 358, tab. 21, fig. 7; *M. cephalus*, SCHAGERSTR., Vet.-Akad. Handl. 1829, p. 90, tab. III, fig. 1, tab. IV, figg. 1—6.

Mugil chelo, CUV., *Règn. Anim.*, ed. 2, tom. II, p. 232; BONAP., *Fn. Ital.*, tom. III (Pesci), tab. No. 91; CUV., VAL., *Hist. Nat. Poiss.*, vol. XI, p. 50, tab. 309, fig. sup.; YARR., *Brit. Fish.*, ed. 2, vol. I, p. 241; THOMPS., *Nat. Hist. Irel.*, vol. IV, p. 100; NILSS., *Skand. Fn., Fisk.*, p. 177; GTHR, *Cat. Brit. Mus., Fish.*, vol. III, p. 454; STEIND., Stzber. Akad. Wiss. Wien, Math. Naturw. Cl., LVII, I (1868), p. 683; COLL., Forh. Vid. Selsk. Christ., 1874, Tillægsh., p. 88; ibid., 1879 No. 1, p. 60; WINTH., *Zool. Dan., Fiske*, p. 16, tab. III, fig. 4; Naturh. Tidskr. Kbhvn, ser. 3, vol. XII, p. 24; MOR., *Hist. Nat. Poiss. Fr.*, tom. III, p. 195; DAY, *Fish. Gt. Brit., Irel.*, vol. I, p. 232, tab. LXVII; MÖB., HCKE, *Fische d. Osts.*, p. 62; LILLJ., *Sv., Norg. Fisk.*, vol. I, p. 396.

Mugil capito, NILSS., *Prodr. Ichth. Scand.*, p. 69; ID., *Skand. Fn., Fisk.*, p. 176.

Mugil curtus, YARR., *Brit. Fish.*, ed. 1, vol. I, p. 210; ed. 2, vol. I, p. 245. Vide DAY, l. c.

Mugil corrugatus, LOWE, *Fish. Madeira*, p. 155, tab. XXII.

Mugil septentrionalis, GTHR, l. c., p. 455; MALM, *Gbgs, Boh. Fn.*, p. 474.

The Thick-lipped Gray Mullet probably attains a greater length than any other species of this genus. As a rule its length probably does not exceed 6 dcm. (including the lobes of the caudal fin), which is the maximum size ascribed by MOREAU to this species. On the coast of Norway, however, COLLETT has met with specimens of as great a length as 665 mm., and according to DAY the species may attain a length of 9 dm. and a weight of $6^2/_3$ kgm. The original of our figure is a smaller specimen, a female measuring 3 dem. from the tip of the snout to the end of the middle caudal rays, in which one or two of the points most characteristic of the species have not yet become so distinct as they sometimes do in other cases. In this genus too, the significance of the changes of growth represents the appearance of the specific differences; and among the Scandinavian species *Mugil chelo* occupies the highest rank in the generic series of development. The character from which the English name of the species is derived, the tumidity of the upper lip, which is usually so marked that the height of this lip is considerably more than half the longitudinal diameter of the eye (from about 60 to 70 % thereof), in our specimen measures only 53 % thereof or only slightly more than it may measure, though it be only in exceptional cases, in full-grown specimens of *Mugil capito*. Similar changes of development in conjunction with individual variations, render the species of this genus extremely difficult to determine. Thus we find in the above list of synonyms that this species has borne the name of all the three chief species of the genus.

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[a] Exceptionally 8·7.

[b] ,, 16·3.

[c] ,, 26·0.

[d] ,, 25·0.

In its general appearance, apart from the structure and position of the fins, the Thick-lipped Gray Mullet, like the two following species, reminds us of a broad-backed Herring or Gwyniad; but the broad-topped, slightly convex and, for the most part, scaly head[a], with the broad snout, at once gives the Gray Mullets a distinctive feature. The colour is not unlike that of the Herring, being a bright, greenish steel-blue on the back[b] and silvery on the belly, but marked with the singular, longitudinal, blue streaks, seven or eight in number, on the sides of the body. The gill-cover is of a bright golden lustre, which, in young specimens at least, is visible through the scales. The pectoral fins (scaly at the base) are pale and transparent, but more or less strongly tinged with yellow and with a more or less distinct black spot at the upper part of the base. The ventral fins, like the belly, are milk-white with a silvery lustre. All the vertical fins are more or less distinctly gray. At least the first three rays of the first dorsal fin are covered on the broader side with small scales, and all the rays of this fin are of the same colour as the back. The second dorsal fin and the somewhat paler anal fin (both covered with small scales on the fin-membrane in front and at the base at least), as well as the caudal fin (with more numerous scales both on the fin-membrane and at the base of the rays), are ashy blue, which is also the predominant colour of the iris, though it has an inner ring of a golden colour next the pupil, which is black. The greater part of the upper lip is grayish black, but inferiorly it grows paler and is white at the margin. Such was the appearance of the young specimen which Mr. C. A. HANSSON forwarded to the Royal Museum from Strömstad, immediately after its capture.

The chief characteristics of the older specimens are the comparatively short head[c], the lower (more elongated) shape of the body[d], the sometimes greater relative distance between the tip of the snout and the first dorsal fin[e], the somewhat shorter ventral fins[f] and the somewhat shorter base of the anal fin[g], while the lower lobe of the caudal fin seems to become shorter and shorter than the upper.

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[a] The breadth of the head behind (straight across the posterior part of the gill-cover) is about $^2/_3$ of its length. From this point the body tapers evenly towards the caudal fin, the breadth (thickness) at the beginning of the first dorsal fin being about equal to or slightly greater than the least depth of the tail.

[b] Cf., however, the above remarks on the variations of colour belonging to different localities.

[c] In the specimens from Bohuslän belonging to the Royal Museum, between 267 and 416 mm. long, the relative length of the head decreases with increasing age from 23·1 to 22 % of the length of the body *minus* the caudal fin, and the length of the head behind the eyes decreases in the same manner from 12·2 to 11·6 % of the latter length.

[d] The greatest depth of the body (at the beginning of the first dorsal fin) decreases in the manner just described from $21^1/_2$ to $19^1/_2$ % of the length of the body (from the tip of the snout to the end of the middle caudal rays); and the length of the head behind the eyes thus increases from 51·7 to 54·8 % of the greatest depth of the body.

[e] This distance increases, in the above specimens, from about 44 to about $45^1/_2$ % of the length of the body or from about 69 to about 73 % of the distance between the anal fin and the tip of the snout, but proves to be somewhat greater in the males than in the females. This change of growth is more distinctly shown in comparison with the length of the head, which decreases from 48 to 45 % of the distance between the first dorsal fin and the tip of the snout.

[f] The relative length of these fins diminishes in the above specimens from 13·3 to 11 % of the length of the body or from about $86^1/_2$ to about 74 % of the length of the pectoral fins.

[g] The length of the base of this fin diminishes in the above specimens from 10·1 to 8·8 % of the length of the body or from 100 to about 90 % of the least depth of the tail.

The external differences between the sexes are not very distinct, but, to judge by the specimens before us[a], they seem remarkable enough. In the males the pectoral fins are generally longer[b], the anal fin higher[c] and the belly shorter[d] than in the females[e]; and in the former the upper lip is apparently thicker and the lower jaw shorter[f].

The Thick-lipped Gray Mullet is the only representative of its genus that may unreservedly be recognised as a stationary fish in Scandinavia. On the Norwegian coast, up to the neighbourhood of Bergen, it is taken so often that it can scarcely be considered rare, though it does not occur in sufficient quantity to give rise to any special fishery. At some spots, says Collett, in Flække Fjord for example, it has been taken on a few occasions in no inconsiderable number. On the coast of Bohuslän it is rarer, and only solitary specimens seem to occur there. The Royal Museum has received 7 examples of this species from Bohuslän since 1837, when a specimen 5 dcm. long was taken in October by Fries, off Bassholm. During the last ten years Mr. C. A. Hansson has sent in 4 specimens from Strömstad, which were taken between May and July. The Museum of Gothenburg, according to Malm, received 5 specimens, which had been taken in Bohuslän between September and November, from 1851 to 1860. We have other specimens from Bohuslän — 6 in all — recorded in Ekström[g] and Cederström[h]. The Thick-lipped Gray Mullet is common enough on the west coast of Denmark, where, according to Winther, it sometimes enters Liim Fjord and the River Ribe. On the east coast of Jutland, according to Warming[i], it occurs annually in Kolding Fjord, where it is taken during September and October, oftenest after storms, in nets on a sandy bottom. In the Sound, off Landskrona, several specimens were found in August, 1828, by Schagerström, who was the first to claim this species for the Swedish fauna. According to Möbius and Heincke solitary specimens have been taken on several occasions, in September and October, in Herring-seines in Kiel Bay; but in the inner parts of the Baltic it is still unknown.

However, the Thick-lipped Gray Mullet, like the other Scandinavian species of this genus, has its true home, where it occurs in shoals, and where a fishery of great value is carried on for it, farther south. Northward from the Mediterranean and the Atlantic outside, it is found in great numbers up to the English Channel, the Irish coast and the west coast of England and Scotland. It is apparently rarer on the east coast of Scotland; but is fairly common, according to Day, even among the Orkney and Shetland Islands. On the coast of Madeira it is common, according to Lowe, and also among the Canary Islands, according to Steindachner.

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[a] Of the specimens belonging to the Royal Museum three are females and two males, while the specimen described and bequeathed to the Museum by Schagerström is probably a male from which all the viscera have been removed.

[b] More than 15 % of the length of the body (though in one of the males this proportion = 15·2) or than 51 % of the length of the belly from the outer point of the insertion of the ventral fins to the beginning of the anal fin.

[c] The height measuring more than 12 % of the length of the body. The length of the base of the second dorsal fin is thus less than 70 % of the height of the anal fin.

[d] The distance between the outer point of the insertion of the ventral fins to the beginning of the anal fin is less than 31 % of the length of the body, and the length of the head more than 67 % of the former.

[e] In all three females the length of the pectoral fins is less than 49 % of the length of the belly from the outer point of the insertion of the ventral fins to the beginning of the anal fin, the height (longest ray) of the anal fin at most 11 % of the length of the body, and the length of the belly, as measured above, between 31 and $32^{1}/_{3}$ % of the length of the body.

[f] In the three females the height of the upper lip is from 18 to $18^{1}/_{2}$ % of the length of the head behind the eyes and from 27 to 29 % of the length of the lower jaw, while in the two males the former proportion is from 20 to 20·8 % and the latter from 31·6 to 33·3. In the third male, however, we find an exception to the ordinary characters of the species, the height of the upper lip measuring only 16·3 % of the length of the head behind the eyes and 25 % of the length of the lower jaw.

[g] Gbgs Vet. Vitt. Samh. Handl. New series, vol. 1, 1850, p. 37.

[h] Öfvers. Vet.-Akad. Förh. 1876, No. 4, p. 65.

[i] Tidskr. f. Fiskeri, 2:den Aarg. (1868), p. 122.

THE GOLDEN MULLET.

MUGIL AURATUS.

Fig. 89.

Adipose membrane round the eyes only slightly developed. Height of the upper lip at most[a] *about $^{1}/_{14}$ (6·3—7·1 %) of the total length of the head, 11—12$^{1}/_{2}$ % of the length of the head behind the eyes, about 24 % (22·2—24·2 %) of the length of the snout, 19$^{1}/_{2}$—22 % of the breadth of the mouth or 20—23 % of the length of the lower jaw. No tubercles on the surface of the upper lip. Length of the snout about $^{1}/_{2}$ (50—52·3 %) of the length of the head behind the eyes, which measures about 12 % (11·7—12·4 %) of the length of the body, 57 % (56·7—57·7 %) of the total length of the head, 57$^{1}/_{2}$—65$^{1}/_{2}$ % of the greatest depth of the body or 27$^{1}/_{2}$ % (27·3—27·7 %) of the distance between the first dorsal fin and the tip of the snout. Length of the lower jaw less than 56 % (54—55$^{1}/_{2}$ %) of the length of the head behind the eyes, of which the breadth of the mouth measures less than 61 % (54—60·2 %). Breadth of the interorbital space at most about 78 % (72·2—77·8 %) of the length of the head behind the eyes. Length of the head as a rule distinctly less than 24 % (22·4—23·3 %) of the length of the body minus the caudal fin or than 49 % (48—48·6 %) of the distance between the first dorsal fin and the tip of the snout. Least depth of the tail less than 75 % (68—73·6 %) of the length of the head behind the eyes and at most about 54 % (48·1—53·5 %) of the length of the pectoral fins, which measures at least 16$^{1}/_{2}$ % (16·7—17·5 %) of the length of the body or $^{1}/_{2}$ (50·3—50·6 %) of the distance between the ventral fins and the tip of the snout. Base of the second dorsal fin more than $^{3}/_{4}$ (78—105$^{1}/_{2}$ %) of the base of the anal fin, than $^{3}/_{5}$ (66—69 %) of the length of the head behind the eyes or than 36 % (37·5—39·8 %) of the total length of the head. Length of the ventral fins at most about $^{2}/_{3}$ (62$^{1}/_{2}$—68 %) of that of the pectoral fins. Middle groove of the roof of the pharynx continued forward — though less marked, shallower and broader than in the preceding species — in the roof of the palate, where, posteriorly at least, it is bounded by a longitudinal, rounded elevation on each side. Tongue also (in front at least) less sharply carinated than in the preceding species. Hind extremity of the preorbital bone obliquely truncate, with the lower corner rounded. Hind (lower) extremity of the maxillary bones, when the mouth is closed, entirely hidden or only a small portion of it externally visible. Greatest breadth of the chin-space more than half the breadth of either of the branches of the lower jaw at the hind extremity.*

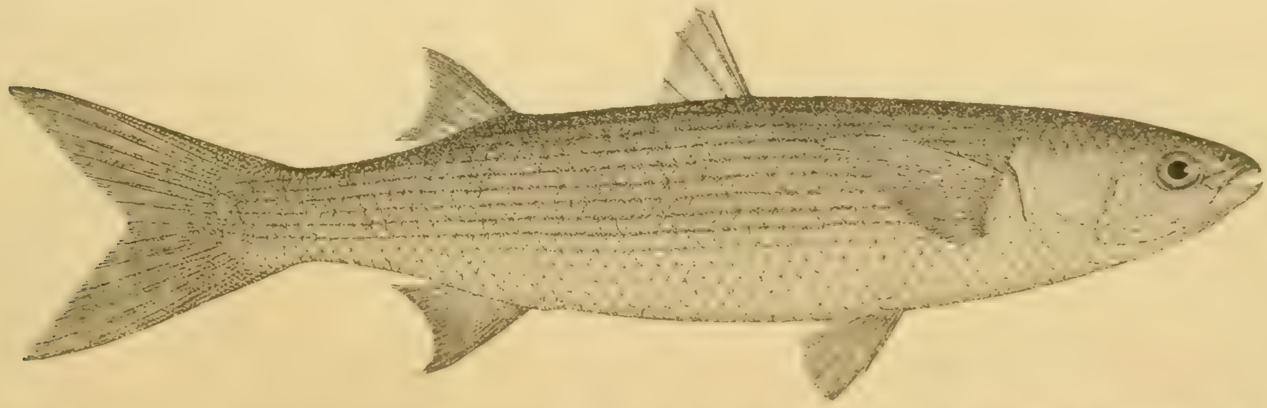

Fig. 89. *Mugil auratus* from Helmestrand (Christiania Fjord), taken on the 15th of June, 1880. $^{1}/_{3}$ of the natural size. The original in the possession of the Museum of Christiania.

R. br. 6; *D.* 4 | 2 + 7; *A.* $^{3}/_{9}$; *P.* 1 l. 2 + 16 l. 17; *V.* $^{1}/_{5}$; *C.* x + 12 + x; *Squ. lin. lat.* 47—49[b], *lin. tr.* 13—14[c].

Syn. *Mugil auratus*, Risso, *Ichth. Nice*, p. 344. *Hist. Nat. Eur. Mér.*, tom. 3, p. 390; Bonap., *Fn. Ital.*, *Pesc.*, tab. No. 92;

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[a] In the specimens before us, which measure between 25 and 45 cm. in length.

[b] 42—45, according to Günther.

[c] 14—15, according to Moreau.

Cuv., Val., *Hist. Nat. Poiss.*, vol. XI, p. 43, tab. 308; *Règne Anim. illustr., Poiss.*, p. 165, tab. 76, fig. 1; Lowe, *Fish. Madeira*, p. 163, tab. 23; Gthr, *Cat. Brit. Mus., Fish.*, vol. III, p. 442; Steind., Stzber. Akad. Wiss. Wien, Naturw. Cl., LVII, I (1868), p. 682; Winth. *Zool. Dan., Fiske*, p. 17, tab. III, fig. 6; Naturh. Tidskr. Kbhvn, ser. 3, vol. XII, p. 25; Lillj., *Sc., Norg. Fisk.*, vol. I, p. 413.

Mugil capito, Hanss., Öfvers. Vet.-Akad. Förh. 1880, No. 4, p. 21; Coll. (p. p.), Nyt Mag. Naturv. Christ., Bd. 29 (1884), p. 72.

The Golden Mullet is evidently an intermediate form between the other two species of this genus that may be included in the Scandinavian fauna. The upper lip is most like that of *Mugil capito;* but the shape of the roof of the palate, as Lilljeborg has pointed out, most closely resembles that of *Mugil chelo.* The most distinctive character lies in the great length of the pectoral fins; and it is on this account that Couch[a] has conferred upon it the name of Longfinned Grey Mullet. The name of Golden Mullet is derived from the fact that in this species, it is stated, the golden-yellow colour of the head, especially of a distinctly marked spot on the gill-cover, in the living fish, is deeper than in the other European species. In other respects, both in colour, general appearance and size, it is essentially like the other two Scandinavian species, though the largest example of this species of which we have information, is somewhat under 52 cm. long.

The geographical extension of the Golden Mullet coincides with that of the preceding species, though it seems to be rarer north of the English Channel. Day does not even include it among the fishes of Great Britain and Ireland. Only three Scandinavian specimens are known. The first, "a small Gray Mullet taken on the 8th of November, 1852, in the Cattegat," is mentioned by Winther (l. c.); the second, which is 295 mm. in length, measured to the end of the middle caudal rays, was taken by Mr. C. A. Hansson in a Salmon-trap, off Strömstad, on the 12th of August, 1877; and the third, which measures 455 mm. to the end of the middle caudal rays and 515 mm. to the end of the upper lobe of the caudal fin, was caught, according to Collett, off Holmestrand in Christiania Fjord, on the 15th of June, 1880. So great, however, is the likeness that prevails among the Scandinavian Gray Mullets, that it is quite possible that other instances of the capture of this species may have failed to attract attention.

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[a] *Fish. Brit. Isl.*, vol. III, p. 19.

THE GRAY MULLET OR THIN-LIPPED GRAY MULLET.

MUGIL CAPITO.

Fig. 90.

Adipose membrane round the eyes only slightly developed. Height of the upper lip at most[a] *about* $^1/_{16}$ *(5·4—6·3 %) of the total length of the head, 9—10*$^1/_3$ *% of the length of the head behind the eyes, about* $^1/_5$ *(19·2—20·6 %) of the length of the snout, about* $^1/_5$ *(17*$^1/_2$*—20 %) of the breadth of the mouth or also about* $^1/_5$ *(16·7—21·2 %) of the length of the lower jaw. No tubercles on the surface of the upper lip. Length of the snout about* $^1/_2$ *(47*$^1/_2$*—50*$^1/_2$ *%) of the length of the head behind the eyes, which measures about 14 % (13—14·2 %) of the length of the body, 60 % (57·8—61·3 %) of the total length of the head,* $^2/_3$ *(71·3—62·8 %) of the greatest depth of the body or 30 % (29·5—32·6 %) of the distance between the first dorsal fin and the tip of the snout. Length of the lower jaw and breadth of the mouth less than 56 % (the former 55—48·5 %, the latter 54*$^1/_2$*—51*$^1/_2$ *%) of the length of the head behind the eyes. Breadth of the interorbital space at most 77 % (66—76·3 %) of the last measurement. Length of the head usually more than 24 % (25·8—24 %) of the length of the body minus the caudal fin or than half (50—53 %) of the distance between the first dorsal fin and the tip of the snout. Least depth of the tail less than 75 % (63—72 %) of the length of the head behind the eyes, but at least about 57 % (57*$^1/_3$*—71 %) of the length of the pectoral fins, which measures at most about 15 % (15·3—14·3 %) of the length of the body or 44 % (44*$^1/_2$*—41 %) of the distance between the ventral fins and the tip of the snout. Base of the second dorsal fin less than* $^3/_4$ *(74—65 %) of that of the anal fin, than* $^3/_5$ *(57*$^1/_2$*—53 %) of the length of the head behind the eyes or than 35 % (33·7—31·5 %) of the total length of the head. Length of the ventral fins at least about 80 % (91—82·7 %) of that of the pectoral fins. Continuation of the middle groove of the roof of the pharynx scarcely visible in the anterior part of the roof of the palate, which is evenly concave without lateral ridges. Middle carina of the tongue low. Hind extremity of the preorbital bone truncate, with both corners almost rectangular. Hind (lower) extremity of the maxillary bones externally visible even when the mouth is closed. Greatest breadth of the chin-space as a rule greater than the breadth of either of the branches of the lower jaw at the hind extremity or at least equal to it.*

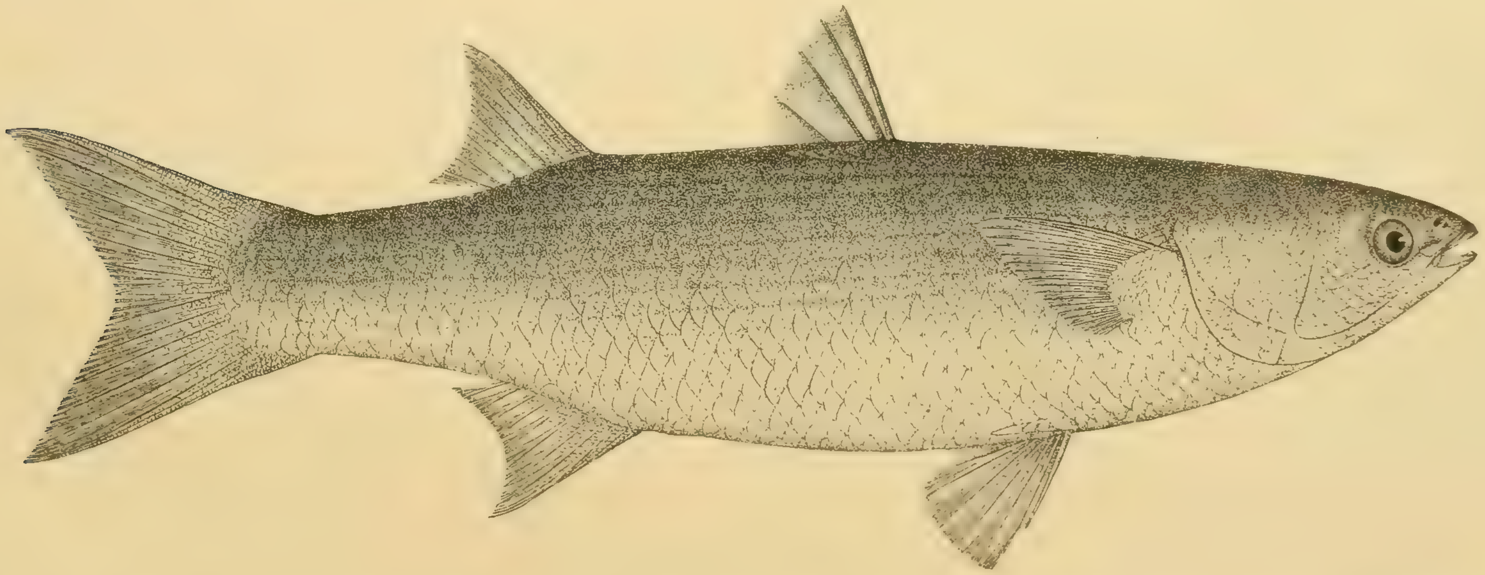

Fig. 90. *Mugil capito* from Flække Fjord (Norway). $^1/_2$ the natural size. Original in the possession of the Museum of Christiania.

R. br. 6; *D.* 4 I + 7 l. 8; *A.* $^3/_9$[b]; *P.* 1 l. 2 + 16 l. 17; *V.* $^1/_5$; *C.* $x + 12 + x$; *Squ. lin. lat.* 44—46; *lin. tr.* 14 l. 15.

Syn. *Mugil*, WILLUGHBY, *Hist. Pisc.*, ed. RAII, p. 274; ART., *Gen. Pisc.*, p. 32; *Syn. Pisc.*, p. 52; *Spec. Pisc.*, p. 71.

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[a] In the specimens before us, which measure between 20 and 36 cm. in length.

[b] Sometimes $^3/_8$, according to MOREAU and DAY.

Mugil cephalus, p. p., Lin., *Syst. Nat.*, ed. X, tom. I, p. 316.
Mugil capito, Cuv., *Règn. Anim.*, ed. 2. tom. II, p. 232; Bonap., *Fn. Ital. Pesci*, tab. No. 92; Cuv., Val., *Hist. Nat. Poiss.*, vol. XI, p. 36, tab. 308; Krøy., *Danm. Fiske*, vol. I, p. 300; Gthr., *Cat. Brit. Mus., Fish.*, vol. III, p. 439; Steind., Sitzber. Akad. Wiss. Wien, Math. Naturw. Cl., LVII, I (1868), p. 680; Coll., Forh. Vid. Selsk. Christ. 1879, No. 1, p. 60; Mor., *Hist. Nat. Poiss. Fr.*, tom. III, p. 188; Day, *Fish. Gt. Brit., Irel.*, vol. I, p. 230, tab. XLVI; Lillj., *Sv., Norg. Fisk.*, vol. I, p. 408.

This species perhaps attains the same size as the Thick-lipped Gray Mullet, and is just as little distinguished from it by any striking difference in form or colour, as the preceding species. The most distinct characteristic of the Gray Mullet is that, among the Scandinavian species of this genus, it has been arrested at the lowest stage in the common course of development. This development, although it does not seem to have started immediately from the Mediterranean *Mugil cephalus*, distinctly points to an original form that essentially corresponded to it, both in the comparatively great length of the head — more than $^1/_2$ the distance between the first dorsal fin and the tip of the snout — and in the even, arched palate, not yet furnished with lateral ridges like the roof of the pharynx, but, on the other hand, with papillæ, partly hardened into teeth, on the lateral parts. We have endeavoured to show the remaining characteristics of this original form in the appended table of averages, based on four specimens, from 196 to 363 mm. long, of *Mugil capito*, three, from 251 to 455 mm. long, of *Mugil auratus*, and six, from 267 to 452 mm. long, of *Mugil chelo*. In this table are also inserted the changes of growth that have appeared in the last-mentioned species in the respects under consideration.

	Average in the case of	*Mugil capito.*	*Mugil auratus.*	*Mugil chelo.*	
	Length of the body expressed in millimetres	267	337	271	363
1	Length of the head in % of that of the body	22.8	21.2	20.9	20.6
2	.. .. behind the eyes	13.8	12.1	11.0	10.9
3	.. .. the distance between the first dorsal fin and the tip of the snout	51.9	48.2	46.9	46.5
4	.. .. behind the eyes	30.9	27.5	24.9	24.7
5	Breadth of the mouth in % of the length of the head	31.4	32.6	35.0	35.6
6	Least breadth of the interorbital space in % of the length of the head behind the eyes	70.8	75.9	82.9	86.8
7	Length of the snout	49.3	51.1	60.5	60.9
8	.. .. .. lower jaw	52.8	54.5	63.0	64.4
9	Least depth of the tail	68.8	70.8	88.6	88.9
10	Length of the base of the anal fin in % of the least depth of the tail	112.9	106.9	97.9	95.9
11	Height of the upper lip in % of the length of the head	5.8	6.7	10.5	9.8
12	.. .. behind the eyes	9.9	11.8	19.6	18.6
13	.. .. snout	20.0	23.0	32.5	30.7
14	.. .. lower jaw	18.8	21.6	31.2	29.1
15	.. .. breadth of the mouth	18.7	20.7	29.9	28.0
16	Length of the base of the second dorsal fin in % of the length of the head behind the eyes	55.8	67.2	73.8	71.4
17	Length of the pectoral fins in % of the length of the body	14.6	17.0	15.4	15.3
18	.. .. the distance between the ventral fins and the tip of the snout	42.9	50.5	45.3	46.1
19	.. .. .. ventral .. .. the length of the pectoral fins	86.8	64,5	80.0	76.7
20	Least depth of the tail	63.5	50.5	64.1	63.5

In all the first ten of the above relations the series advances in the same direction, and is followed by the changes of growth in *Mugil chelo*. A comparison between the first and the third columns, in which the length of the body is almost the same, shows the distinctive characteristics of *Mugil capito*, as well as of the supposed origin which may have been the starting-point of the common development. The next five relations (11 to 15 inclusive) show the most distinctive character of *Mugil chelo;* but it is singular that here the changes of growth in this species — as though it underwent a retrograde development — run in the opposite direction to the form-series, which, on the other hand, follows the direction of the changes of growth in *Mugil capito*, to judge by the specimens before us[a]. In the 16th relation we again find a character of *Mugil capito*; but here the form-series follows the changes of growth which apparently affect *Mugil auratus*. In the next four relations (17 to 20 inclusive) is expressed the most distinctive character of the last-mentioned species.

The Gray Mullet is one of the rarest visitors to the Scandinavian fauna. Krøyer and Esmark alone have each received one specimen. Both these specimens were of about the same size, measuring about 4 dcm. in length to the end of the lobes of the caudal fin, and were caught off the south coast of Norway. The former writer received his specimen from Christiania Fjord[b], the latter from Flekke Fjord. In the latter specimen, which has been kindly lent us for examination by Professor Collett, we find several exceptional peculiarities, e. g. the unusually small eyes[c] and the great depth of the body[d], deviations which are probably, however, only individual.

The geographical range of the Gray Mullet, according to Day, extends as far south in the Atlantic as the Cape of Good Hope. In the North Sea it is said to be rare, but all the more common farther south. In the countries bordering on the Mediterranean, and even on the west coast of France and the south coast of England, it probably enters fresh water more frequently than any other species of the genus. In Algiers, according to Guichenot, it ascends all the rivers. It is also known in the lakes of Tunis and in the Nile.

Here end the Acanthopterygian Eleutherognates that belong to the Scandinavian fauna: the following forms are soft-finned, *Malacopterygii*, generally without spinous rays and with only articulated rays, both in the vertical and the ventral fins. As in the preceding Eleutherognates, we have here too, to distinguish between Pharyngognates and Lysipharyngians, and here, as there, we set the Pharyngognates first, though in one of the points most characteristic in other cases they bear traces of the lower stages of development of the Teleosteous type. In the Pharyngognate Malacopterygians, though the ventral fins are furnished with the number of rays typical of the Physoclysts (6), they are set far back or abdominal, and the pelvic bones bear, at the hind outer corner, an erect process, the Ganoid nature of which we can more easily realise by comparing it with the analogous structure in the Sticklebacks (*Gasterosteidæ*). Furthermore, on account of the position of the ventral fins, the Pharyngognate Malacopterygians have usually been ranged low down in the system, beside the Pikes and other Physostoms. But apart from their closed air-bladder, which gives them a place among the Physoclysts, they show such close resemblance to the Gray Mullets that for the sake of this connexion we allow the above-mentioned morphological reason — the higher degree of metamorphosis expressed by the coalescence of the lower pharyngeals — to decide their place in the system.

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[a] We must remark, however, that in estimating the above average we could gain access to no young specimen of *Mugil capito*; and it is by no means unusual that the relations which exist during youth, are reversed in older specimens.

[b] That Krøyer's specimen really belonged to this species, is shown by the measurements he has given. According to these the length of the base of the second dorsal fin was 35 % of the length of the head and 74 % of the length of the base of the anal fin, which was 11 % of the length of the body measured to the end of the middle rays of the caudal fin. The length of the head was 51 % of the distance between the first dorsal fin and the tip of the snout.

[c] Their diameter is only about 12 % of the total length of the head and 20 % of the length of the head behind the eyes, while in other examples of this species, as well as of the other two, these proportions respectively decrease with age from about 19 % to 17 or 16 % and from 33 or 34 % to 29 or 28 %.

[d] The greatest depth of the body is $32^1/_2$ % of the length thereof, while the highest proportion reached by this measurement in other specimens of *Mugil capito*, as well as in *Mugil auratus*, is only $20^1/_2$ %.

SYNENTOGNATHI.

Malacopterygian Eleutherognates with the lower pharyngeals united. Body covered with cycloid scales, the lateral line set low down and following a raised row of distinct scales along each side of the belly. Dorsal fin situated on the caudal part of the body, and the anal fin analogous to it in shape and position. Ventral fins abdominal. Nasal cavities open. Air-bladder, when present, generally large and sometimes internally divided into cells. Pseudobranchiæ glandular and overgrown. Branchiostegal rays generally more than 10. Digestive canal simple, straight, with scarcely distinguishable stomach and without pyloric appendages[a].

Even in JOHANNES MÜLLER[b] this series of piscine forms was essentially defined, in characters and contents, as a distinct family, *Scombresoces*, or, regarded as a sub-order, *Pharyngognathi malacopterygii*. It was an extract from the older genus *Esox* of LINNÆUS and CUVIER, which had, however, been previously broken up, first by RAFINESQUE[c] and afterwards by CUVIER himself and BONAPARTE. The last writer arranged these forms in two subfamilies[d], *Belonini* and *Exocoetini*, within the family of the Pikes. COPE united them[e] into a distinct suborder among the Physoclysts under the name of *Synentognathi*.

In the external appearance of the body these fishes show a distinct resemblance to the Gray Mullets in the more or less broad and flat dorsal side, especially at the head, the greater part of which is here too, covered with scales. The high position of the pectoral fins also suggests this likeness, which is still more strongly expressed in the structure of the skeleton. Here too, the skull is broad and flat at the top, with excessively large frontal bones and without ridges, but with the backward processes from the squamosal bones (*ossa pterotica*), the mastoids (*ossa epotica*) and the lateral occipitals well-developed and often elongated, as we have found them in *Mugil*. The spinous processes of the anterior abdominal vertebræ are also longitudinally extended and contiguous. On the under surface of the basilar part of the occipital bone, sometimes in the middle as well as on the sides, we find downward processes resembling the analogous formations in the Carps.

In the other respects, however, the Synentognates range themselves in sharp contrast to the Gray Mullets. Not only are the structure and function of the pharyngeal apparatus entirely different, the upper pharyngeals being comparatively small, but strong and closely set with teeth, the lower also furnished with teeth and still further strengthened by their coalescence; but, in addition to this, the straight, but fairly wide, intestinal canal, which, however, gradually grows narrower posteriorly, and is without any distinct stomach, offers the most entire contrast to the winding digestive canal of the Mugiloids.

One of the most remarkable characteristics of the Synentognates appears in the smelling-organ. The nostrils are open cavities, situated just in front of the eyes; and the olfactory organ itself is set on a transverse swelling or dermal fold that rises at the bottom of each cavity.

In some of the species of the genus *Hemiramphus* VALENCIENNES[f] found the air-bladder internally divided into cells, calling to mind the similar formations in the genus *Amia:* and GÜNTHER, who ranged the Synentognates in close proximity to the *Cyprinodontidæ*, grounded his opinion chiefly on the sexual difference, first remarked by VALENCIENNES[g], in those species of the genus *Hemiramphus*, to a great extent fresh-water fishes, which have subsequently been assigned by GILL[h] and BLEEKER[i] to the genus *Zenarchopterus*. In these species, which, like the majority of the *Cyprinodontidæ*, are viviparous, and in which the ova must, therefore, be fertilized within the uterus, the males are distinguished partly by a papilla behind the vent and partly by the advanced development of some of the rays of the anal fin (sometimes of the dorsal fin as well). These rays grow longer and thicker than the others, and sometimes acquire pseudorays on the hind margin, like the still more prominent growths in the Ganoid genus *Polypterus*.

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[a] According to DAY the genus *Scombresox* possesses pyloric appendages. We have failed to find any.

[b] Abh. Akad. Wiss. Berlin 1844, Phys. Abh., p. 170.

[c] See SWAINSON and BLEEKER, ll. cc. RAFINESQUE'S work has not been accessible to us.

[d] Nuov. Ann. Sc. Nat., Anno II, tomo IV (Bologna, 1840), p. 274.

[e] Trans. Amer. Phil. Soc., Philad., N. ser., vol. XIV, pp. 456 and 457.

[f] CUV., VAL., *Hist. Nat. Poiss.*, vol. XIX, p. 3.

[g] L. c., p. 58.

[h] Proc. Acad. Nat. Sc. Philad. 1863, p. 273.

[i] *Atl. Ichth. Ind. Or. Néerl.*, tom. VI, p. 61.

In the Synentognates the system of the lateral line is most highly developed in the lateral line itself, which is situated low down, and generally runs along a somewhat elevated carina on each side of the belly from the lower anterior corner of the clavicular region to the base of the caudal fin, being more or less complete throughout its course. Sometimes, on the tail behind the anal fin, it curves upwards on a middle carina along each side of the body, and advances over the membrane between the middle rays of the caudal fin. However, the lateral line, as usual, originates in the temporal region, and a connective branch, which is often visible externally, runs downward behind the pectoral fin and joins the ventral branch below this point[a]. The system of the lateral line on the head generally opens into a number of scattered, small, round pores on the posttemporal bone, the temporal region, anteriorly on the forehead above the eyes, sometimes out on the intermaxillary bones, when they are elongated, and also on the posterior and inferior margins of the preoperculum, from which point the row is continued on the branches of the lower jaw, when they are elongated.

The ova of all these fishes, to the best of our knowledge, are furnished with filaments on the shell[b], like those we have noticed above in *Gobius niger*, but arranged in a different manner, being scattered over the surface of the shell (fig. 91). By means of these filaments the eggs are united into clusters or attached to seaweed or other objects at the bottom of the sea, the water in which they lie, being thus constantly changed by the ebb and flow of the tide.

The Synentognates are active surface fishes, the great majority of them being pelagic; but some of them enter the lagoons, or, like several of the Mugiloids, ascend the rivers, or are even stationary fresh-water or brackish-water fishes. According to GÜNTHER's *Catalogue* about 180 species have been named, defined with more or less certainty and distributed among 5 genera. GILL and BLEEKER have subsequently adopted 13 distinct genera for these forms. Most writers have included all the Synentognates in one single family,

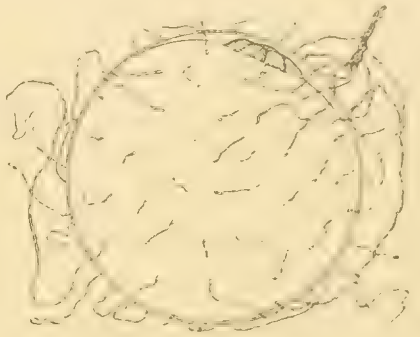

Fig. 91. Egg of a Garpike enclosed in the shell, which is furnished with tentacular threads on the surface. The egg had undergone fertilization 3 h. 23 min. previously. Germinal disk (*g*) divided into 8 segments Magn. $11^{1}/_{6}$ diam. After RYDER.

FAM. SCOMBRESOCIDÆ,

the characters of which thus coincide with those already given for the whole group.

On account of the difference in the jaw-teeth, however, GILL[c] established two families: *Belonidæ*, with sharp, sparse teeth, and *Scombresocidæ*, with small jaw-teeth or destitute thereof. BLEEKER (*Atl. Ichth.*) adopted four subfamilies: *Scombresociformes*, with both jaws elongated and with finlets behind the dorsal and anal fins; *Mastacembeliformes*, also with both jaws elongated, but without finlets; *Hemiramphiformes*, with only the lower jaw elongated like a spear-head, the upper jaw forming a triangle in front of the snout proper; and lastly, *Exocoetiformes*, with neither of the jaws elongated into a beak. The first three subfamilies are further distinguished from the fourth by the fact that in their case the maxillary bones are more or less firmly united to the lateral parts of the hind superior margin of the intermaxillary bones, in a manner which calls to mind the structure of the Plectognates, though here these bones may more easily be distinguished from each other, while the intermaxillary bones have a thin, but broad margin straight across the snout, and articulate with the anterior margin of the nasal bones. In the *Exocoetiformes*, on the other hand, the maxillary bones lie free and mobile, in their ordinary position behind the intermaxillary bones, each of which articulates by means of a very short nasal process with the anterior end of the ethmoid bone, being thus to a certain extent protrusile, though generally only slightly so. This difference may also be expressed by BONAPARTE's arrangement of these forms in two subfamilies, *Belonini* and *Exocoetini*, though he based the definition of these subfamilies only on the greater or less elongation of the pectoral fins, a character which is rendered untenable by the intermediate forms. Like BONAPARTE, though on different grounds, we, therefore, divide these fishes into two subfamilies.

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[a] We have not succeeded in finding a trace of the upper lateral line, which according to VALENCIENNES (CUV., VAL., *Hist. Nat. Poiss.*, vol. XVIII, p. 406) and BONAPARTE (*Fn. Ital.*, tom. III, 2 — *Pesci* — *Belone acus*) runs along the upper part of the sides of the body. VALENCIENNES states, however, that he has been able to trace the lateral nerve throughout the whole of its course.

[b] HÆCKEL, MÜLLER's Arch. f. Anat. 1855, p. 23, tafl. IV and V; KÖLLIKER, Verh. Phys., Med. Ges. Würzb., vol. VIII (1858), p. 80; RYDER, Bull. U. S. Fish. Comm., vol. I, p. 283, pl. XIX—XXI.

[c] *Arr. Fam. Fish.*, Smiths. Misc. Coll., No. 247, p. 14.

SUBFAMILY **BELONINÆ.**

Intermaxillary bones, which are entirely without lips, firmly united to each other and to the maxillary bones, and articulating by means of a broad edge with the anterior margin of the nasal bones. Lower jaw (and often the upper jaw as well) elongated into a beak or sword.

The Scandinavian fauna contains two species belonging to this subfamily, each of them representing a distinct genus:

A: Only one dorsal and one anal fin; no finlets behind them ... . Genus *Ramphistoma*.
B: Several (6—8) finlets behind the dorsal fin as well as the anal .... Genus *Scombresox*.

GENUS **RAMPHISTOMA**.

Both jaws (the under one most so) elongated into a long, narrow beak, armed with scattered, large teeth and more closely-set small teeth between the former. Body long, eel-like and covered with small scales. No finlets behind the dorsal or the anal fin.

KLEIN, who in 1744 gave this genus the name of *Mastacembelus*[a], which was afterwards adopted by BLEEKER, was indeed the first to define and characterize it. However, this name is older than the system of nomenclature now in vogue (KLEIN did not recognise the Linnæan binomial nomenclature), and GRONOVIUS and, after his time, CUVIER and VALENCIENNES have given it an entirely different application in ichthyology, a circumstance which might easily lead to confusion. As we are, therefore, debarred from recognising this generic name, the only course left for us is to adopt the oldest binomial name proposed for the genus, which was established by RAFINESQUE in 1815, and afterwards adopted by SWAINSON[b]. *Belone*, the name proposed by CUVIER[c], is more widely known, but two years younger; and may, therefore, with justice reassume its original signification as a Linnæan specific name.

Ramphistoma[d], the genus of the Garpikes, contains about 50 species recognised up to the present; and its geographical range extends all round the world between the polar circles, some of the species also occurring in fresh water in India and Brazil. They are well-known enough, partly on account of their long, narrow beak, their eel-shaped, but rather quadrangular body, their winding motions, which also remind us of the Eels, their mackerel-like coloration, and partly on account of the green colour of their bones, which in many places has caused them to be suspected of being poisonous[e]. No grounds, however, have been given for this suspicion; and in many places these fishes are much esteemed as food. At certain times they approach the coast in shoals; and then they are sometimes taken in enormous quantities, thus being of great economical importance to man. Some of them also attain a considerable size. One species, the principal object of sport for the English garrison in Bermuda, is said to attain a length of 5 or 6 feet (15—18 dm.). They are pronounced fishes of prey, though they can swallow only comparatively small objects, such as small fishes, crustaceans and insects. "I have seen a Needle-fish[a]," says Stearns[b], "of fifteen or twenty inches length seize mullet and other fish fully one third of its own size, which often prove more than it can manage. They are sometimes washed ashore dead, with some spiny fish that was a little too large fixed in their throats." Their voracity, however, renders the Garpikes real pests to other fishes, especially small fry.

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[a] *Hist. Pisc.* Miss. 4, p. 21.

[b] *Nat. Hist. Fish., Amph., Rept.*, vol. I, p. 296 and vol. II, p. 187.

[c] *Règne Animal*, edit. I, tom. II, p. 185.

[d] *ῥάμφος, beak* and *στόμα, mouth.*

[e] In his report of the fish and fisheries of New South Wales (p. 83) TENISON-WOODS mentions "one or two doubtful cases" of this poisoning. See also LITTRÉ and ROBIN, *Dict. Medic.* art. *Vénéneux.* KROYER also states that in his time the same belief in the poisonous properties of the flesh of the Garpike was current among the populace at certain spots on the west coast of Norway.

In a systematical respect the Garpikes like the following genus, are of special interest on account of their changes of growth. In the harbour of Polperro (Cornwall), in July, 1818, Couch[c] found a small fish, about an inch long, actively swimming about at the surface, which he took to be Linnæus's *Esox brasiliensis*, i. e., according to the system of modern times, a representative of *Hemiramphus*, a genus common in the tropic seas, with only the lower jaw elongated, the upper jaw forming a more or less nearly equilateral triangle. In August, 1837, on the other side of England, off the coast of Suffolk, Clarke[d] also found a shoal of this fish, about two inches long, and supposed them to be the young of the common Garpike. This was also Behn's[e] opinion of the large shoals of similar small fish, between 20 and 36 mm. long, which he found in Kiel Bay in June, 1842, and specimens of which were shown in the same year by Van der Hoeven at the Meeting of Scandinavian Naturalists in Stockholm[f]. Yarrell[g] and Hornschuch[h], on the other hand, were of opinion that these young specimens were true *Hemiramphi*, and that the fauna of Europe thus contained one[i] or even two[j] species of this tropical genus. Valenciennes rejected this opinion, and unhesitatingly stated[k] that "in early youth the Garpikes have a short beak, and the lower jaw is elongated before the upper jaw has reached its full development. Rüppell has made the same remark with regard to the Sauries (*Scomberesox*)." This was one of the first observations to give undisputable evidence of the natural development of these genera from one another. The *Hemiramphi* represent the earlier stages of the development of the family; and the forms which occupy the more advanced stages of this course of development, the Garpikes and Sauries, pass through Hemiramph stages in their youth. The course of this development has subsequently been still further elucidated by Malm[l] and Lütken[m]. We have borrowed from the latter author the instructive figures which he has appended to his description of the changes of the head during growth both in *Scombresox* and *Ramphistoma*[n]. In early youth (fig. 92, *α*), while the length of the body is still less than 13 mm., both jaws are short, like those of the Flying-fish. In specimens 15 mm. long the lower jaw projects, with a protuberance, bent downwards, under the tip, while the upper jaw is still almost truncate or forms a broad obtuse angle. In specimens 25 mm. long the snout and lower jaw roughly present the appearance shown in fig. *β* in the woodcut, with the tip of the lower jaw bent downwards; and along the middle of the under surface of the lower jaw there hangs a dermal fold, black at the margin, which strongly reminds us of the corresponding growth in the true *Hemiramphi*[a]. Here this fold disappears during growth, though in specimens 60 mm. long it is still present, but stunted. The following changes in the shape of the snout and the length of the lower jaw are represented in the figures. In specimens about 60 mm. long the head is roughly of the shape shown in fig. γ in the woodcut. It still resembles that of *Hemiramphus:* the front angle of the snout has passed from obtuse to right and finally to acute; but the tip of the snout is now marked off from the sides by a little sinus on each side: this is the beginning of the elongation of the upper jaw, and while this proceeds, teeth appear in that part of the lower jaw that corresponds to the upper. In specimens about 70 mm. long the head is of the shape shown in fig. δ in the woodcut; and in specimens about 150 mm. long the snout has assumed the shape typical of the Garpikes, though the upper jaw is still considerably (about three times the diameter of the eye) shorter than the lower. In full-grown Garpikes the difference in the length of the jaws is only equal to or $^1/_3$ less than the diameter of the eye.

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[a] This is the name given to the Garpike or Silver Garfish by the fishermen of the Gulf of Mexico, as well as those of Italy and Spain.

[b] Brown-Goode, *Fish., Fish. Industr. U. S.*, sect. I, p. 459.

[c] *Trans. Lin. Soc. Lond.*, vol. XIV, part. I, p. 85.

[d] Yarr., *Brit. Fish.*, ed. 2, vol. I, p. 451.

[e] Tijdschr. v. Natuurl. Gesch., vol. X (1843), p. 5.

[f] See the Proceedings of the Meeting, p. 648.

[g] *Brit. Fish.*, l. c.

[h] Tijdschr. Nat. Gesch., l. c., p. 296.

[i] *Hemiramphus europæus*, Yarr.

[j] *Hem. balticus*, Hornsch., a name which V. d. Hoeven, however, proposed to exchange for *Hem. Behnii.*

[k] Cuv., Val., *Hist. Nat. Poiss.*, vol. XIX, p. 6 — 1846.

[l] Gbgs Vet., Vitt. Samh. Handl., Ny Tidsföljd, Häft. 2 (1851), p. 106; Öfvers. Vet.-Akad. Förh. 1852, p. 230, tab. III, fig. 2; *Gbgs, Boh. Fn.*, p. 554.

[m] Vid. Selsk. Skr. Kbhvn, 5:te Række, Naturv., Math. Afd., vol. XII, p. 564.

[n] The Royal Museum has received an abundant supply of young specimens of *Ramphistoma*, between 15 and 60 mm. long, partly taken by Mr. C. A. Hansson in the neighbourhood of Strömstad and Dynekil, in the month of July, and partly from the Skager Rack, where, in July, 1879, the Expedition of the gunboat *Gunhild* found the young of this species at the surface in about 330 fathoms of water.

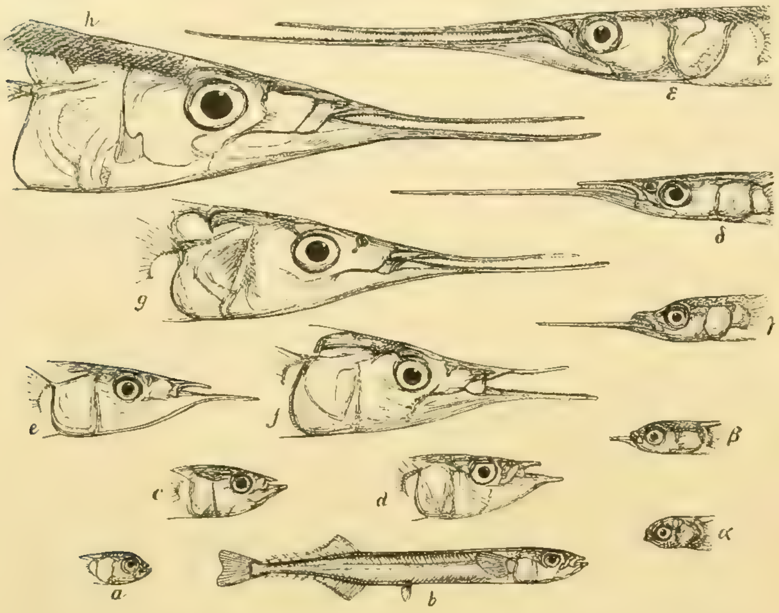

Fig. 92. Postembryonic changes of growth in the heads of *Scombresox* and *Ramphistoma*. After Lütken. Figs. *a—h* of *Scombresox saurus; α—ε* of *Ramphistoma belone. a* magn. 3 diam.; *b* $^1/_5$ more than the natural size; *c* and *d* $^1/_2$ more than the natural size; *e* $^1/_5$ more than the natural size. *f* $^1/_6$ less than the natural size; *g* $^1/_3$ less than the natural size; *h* $^1/_4$ less than the natural size. *α—δ* magn.; *ε* $^1/_4$ less than the natural size. For further explanation see the text.

The development of the fins presents the usual changes, but interests us by a characteristic peculiarity, the persistency of a part of the embryonic (larval) vertical fin and the late appearance of the ventral fins. Even in a young Garpike 15 mm. long this vertical fin is still present at the lower caudal margin, between the anal and caudal fins: between the dorsal and caudal fins it has disappeared; but at the ventral margin, from the vent to the end of the first third of the length of the abdomen, a great part of it, measuring more than half the depth of the body at this point, is still persistent. As yet only the caudal fin, which is of a rounded shape, contains distinct rays. In the anal fin, the anterior part of the dorsal fin and the upper part of the pectoral fins, which are lobate (furnished with a semi-elliptical basal part) and round, more or less distinct rudiments of the true rays now begin to form; but the remainder of each of these fins is supported by the primary fibrillæ alone. Not a trace of the ventral fins is externally visible, with the exception of a light, round spot on each side of the base of the vertical abdominal fin, the distance between it and the vent being scarcely $^1/_3$ of the length of this fin. This spot forms a scarcely perceptible contrast to the rest of the surface of the body, which is thickly strewn with blackish green collections of pigment[b]. At these points the ventral fins appear first in the form of small protuberances, which assume a lobate form. But, even in specimens $25^1/_2$ mm. long — where the vertical abdominal fin is still almost unchanged, and the pigmental spots on the body still present — the ventral fins appear almost as microscopical lobes. In specimens 53 mm. long distinct traces of the vertical abdominal fin are still present, but the pigmental spots on the belly and the lower part of the sides have begun to disperse, and to give place to the incipient silvery lustre. The ventral fins are even now scarcely more than half a millimetre long, while the length of the pectoral fins is fully 3 mm. or exactly equal to the postorbital length of the head.

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[a] See Bleeker, *Atl. Ichth. Ind. Neerl.*, pp. 53 etc., tab. *Scombres.* IV, VI—VIII.

[b] On the upper part of the body these spots are set in fairly regular longitudinal and oblique transverse rows, the former being especially distinct at the middle of the back. On the lower part of the body they are irregularly arranged in longitudinal rows, and they are wanting only on the under surface of the head and of the front part of the belly, as well as on the opercula.

THE GARPIKE (SW. NÄBBGÄDDA).

RAMPHISTOMA BELONE.

Plate XXIII, fig. 3.

Setiform gill-rakers in an outer row on the front of the first branchial arch; gill-rakers in the inner row of this arch, and also in both rows on the three posterior branchial arches verrucose. Dorsal and anal fins falciform, with the anterior part elongated to a point and twice or more than twice as high as the posterior part of these fins, where the rays are of uniform height. No lateral carina on the tail, the breadth of which, at the shallowest part of the body, generally measures about $^3/_4$ or $^7/_8$ of the depth of the body at this point[a]. *The lateral line runs along the margin of the belly and ends at the termination of the anal fin. Longitudinal diameter of the eye in full-grown specimens (between 6 and 8 dm. long) from about 35 to 30 % of the postorbital length of the head, or from 78 to 66 % of the least breadth of the interorbital space.*

R. br. 9—13; *D.* 2+16 l. 17[b]; *A.* 2+19 l. 20[c]; *P.* 1+12; *V.* 1+5; *C.* *x*+13[d]+*x*; *Vert.* 80—84.

Syn. *Acus*, PLIN., GAZ., cett. vet. (vide ARTEDI, *Syn. Pisc.*, p. 27); *Acus prima species*, RONDEL., *De Pisc.*, lib. VIII, cap. 3; *Acus vulgaris sive Oppiani*, WILLUGHBY, *Hist. Pisc.*, p. 231, tab. P, 2, fig. 4.

Esox Bellone, LIN., *Syst. Nat.*, ed. X, tom. I, p. 314; *Esox Belone*, LIN., *Fn. Suec.*, ed. II, p. 126; BL., *Fisch. Deutschl.*, pt. I, p. 236, tab. XXXIII; MÜLL., *Zool. Dan. Prodr.*, p. 49; MOHR, *Isl. Naturh.*, p. 82; RISSO, *Icht. Nice*, p. 330; SWARTZ, *Sv. Zool.*, tom. II, No. 40; REUTER et SUNDM. (*Belone*), *Finl. Fisk.*, tab. XXI.

Belone acus, RISSO, *Eur. Mér.*, tom. III, p. 443; EKSTR., Vet.-Akad. Handl. 1831, p. 70; BONAP., *Icon. Fn. Ital.*, tom. III, Pesci, tab. 122; CUV., VAL., *Hist. Nat. Poiss.*, vol. XVIII, p. 414; GTHR, *Cat. Brit. Mus.*, *Fish.*, vol. VI, p. 251; STEIND., Stzber. Akad. Wiss. Wien, Math. Naturw. Cl., Bd. LVII, I (1868), p. 732; MOR., *Hist. Nat. Poiss.*, *Fr.*, tom. III, p. 472; LILLJ., *Sv.*, *Norg. Fisk.*, vol. II, p. 436.

Belone vulgaris, FLEM., *Brit. Anim.*, p. 184; NILSS., *Prodr. Ichth. Scand.*, p. 37; CUV., VAL., l. c., p. 399; NILSS., *Skand. Fn.*, *Fisk.*, p. 354; MGRN, *Finl. Fisk.* (disp. Helsingf. 1863) p. 67; LINDSTR., *Gotl. Fisk.*, Gotl. Hush. Sällsk. årsber. 1866, p. 18 (sep.); COLL., Forh. Vid. Selsk. Christ., 1874, Tillægsh., p. 176; SEIDL., *Fn. Balt.*, p. 92; COLL., l. c. 1879, No. 1, p. 94; WINTH., Naturh. Tidskr. Kbhvn, ser. 3, vol. XII, p. 86; MELA, *Vert. Fenn.*, p. 356, tab. X; DAY, *Fish. Gt. Brit.*, *Irel.*, vol. II, p. 147, tab. CXXVII, fig. 1; MÖB., HCKE, *Fisch. Osts.*, p. 68; COLL., N. Mag. Naturv. Christ., Bd. 29 (1884) p. 110; BNCKE, *Handb. Fischz. Fischer.* (M. V. D. BORNE), p. 101.

Belone rostrata, FABER., *Fisch. Isl.*, p. 152; NORDM., *Voy. Russ. mér.* (DEMIDOFF), tom. III, p. 514, tab. 25, fig. 1; KR., *Danm. Fiske*, vol. III, p. 255; BNCKE, *Fisch.*, *Fischer.*, *Fischz. O-. Westpr.*, p. 101.

Obs. *Βελόνη* in ARISTOTLE, as SWARTZ[e] and VALENCIENNES[f] have already shown, undoubtedly referred to the Pipe-fishes (*Syngnathus*).

The Garpike, in Sweden known as *Näbbgädda* (Beaked Pike) or, more commonly on the west coast, *Horngädda*, *Horngäll* or *Hornfisk*, attains a length of nearly 94 cm., according to KRØYER. The largest specimen we have examined, was from the Sound and measured 82 cm. in length[g] to the end of the middle rays of the caudal fin. NILSSON states that in Sweden the average length of the species is between 64 and 74 cm. The form of the body varies considerably with age: in specimens between 160 and 200 mm. long the depth is still only about 5 % of the length, while in specimens between 700 and 800 mm. long the depth is about 8 or 9 % of the length. The breadth of the body and its sectional shape are just as variable: the greatest breadth (thickness) is generally about $^2/_3$ of the greatest depth, but in old specimens sometimes rises to at least 72 % thereof. In young specimens the body is often sharply compressed from the broad dorsal side to the ventral edge, while in the older specimens the abdominal region is more terete in a quadrangular shape, the lower part of the head compressed, and the tail more cylindrical. The abdominal region is throughout of fairly uniform depth; but the head anteriorly assumes the typical beak-like shape, and the tail tapers from the very beginning of the anal fin, the least depth of the body, just in front of the caudal fin, decreasing with age, in the specimens mentioned above, from 35 to 25 % of the greatest depth thereof.

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[a] Sometimes, however, the breadth of the body at this point is equal to the depth.

[b] Sometimes 2+18, sometimes 2+15.

[c] Sometimes 2+21, sometimes 2+16, 2+17 or 2+18.

[d] Sometimes 14, according to DAY and LILLJEBORG.

[e] *Sv. Zool.*, II, No. 40, p. 43.

[f] CUV., VAL., *Hist. Nat. Poiss.*, vol. XVIII, p. 396.

[g] In this species the length of the body is measured from the tip of the lower jaw.

The length of the head, which during early youth is increased by the elongation of the jaws more than the other parts of the body, in specimens about 200 mm. long measures $^1/_3$ of the length, but afterwards sinks to about 27 % thereof. The greater part of the length of the head is formed, as we have mentioned, by the jaws. The length of the lower jaw may rise to about 27 % of that of the body or 87 % of that of the head, but sinks with age to about 19 % of the former or 73 % of the latter. The upper jaw is invariably the shorter, but the difference, which in specimens about 200 mm. long may be at least 23 % of the length of the lower jaw, is to a certain extent reduced by age, and eventually sinks so low that the length of that part of the under jaw which projects beyond the upper, is only 7 % of the total length thereof. Both jaws, to the end of the upper, are armed with straight, pointed teeth, consisting partly of large, scattered teeth set in a row and partly of one or more rows of smaller teeth outside this row. In the greater part of the upper jaw and on the hind part of the margin of the lower these teeth form a perfect card; and in the upper jaw the teeth in the outermost row point straight outwards. The intermaxillary bones are united throughout their length, and the branches of the lower jaw in the outer (anterior) part for about half their length. On the inner (upper) side of this coalescent part (in the groove of the lower jaw) there runs along the mesial line of the jaw an osseous ridge forming numerous zigzag turns, which remind us of the enamelled curves in the compound teeth of certain mammals. On the head of the vomer there occurs a very inconstant and sometimes entirely absent, oblong card of teeth, narrowing behind to a point, the presence of which has been supposed to distinguish our Garpike from the Mediterranean form. We have learnt, however, from STEINDACHNER's observations that the Mediterranean Garpike of this species sometimes possesses these vomerine teeth, and KRØYER had already shown that our Garpike is very often without them[a]. As we have mentioned above, the upper jaw is without any trace of lips; but on each side of the lower jaw, starting at the corner of the mouth, there hangs a narrow dermal fold, which may sometimes, though indistinctly, be traced nearly to the tip of the jaw. The palatal folds, the inner transverse *vela*, are well-developed in both jaws. The tongue is fleshy, toothless, and obtusely rounded at the tip. In young specimens the profile of the snout slopes gradually from the forehead itself; but in older ones the base of the upper jaw (the intermaxillary bones) is considerably tumid.

The forehead is flat or only slightly convex, and the boundary between it and the cheeks, which converge inferiorly, is sharply marked by a somewhat acute angle. The eyes are set in the same plane as the cheeks and in front of the perpendicular from the articulation of the lower jaw. Their diameter is somewhat greater longitudinally than vertically. The sides of the snout above the lower jaw are formed chiefly by the triangular preorbital bones, which, when the mouth is closed, cover the lateral branches of the intermaxillary bones and the maxillary bones, which are respectively united to the latter. Above the preorbital bone, on each side of the snout, lies the triangular nostril, the singular structure of which we have described above, with the longest corner pointing in a forward direction. The white, transverse ridge is parallel to the hind side of the cavity. The postorbital part of the head, which, at the end of the singular alterations during youth, measures about $^1/_5$ of the total length of the latter, subsequently increases to such an extent that it eventually measures $^1/_4$ or even 27 % thereof. The thin hind margin of the preoperculum is rectangular or even acute-angled, with the lower posterior corner rounded. The operculum, the length of which is about $^1/_2$ that of the postorbital part of the head, in shape resembles "a quadrant," as NILSSON has happily observed; and outside (below and behind) this quadrant comes the falciform suboperculum, with the point situated at the upper corner of the gill-opening and the base touching the base of the interoperculum, which forms an elongated triangle, growing narrower in front and united by a ligament to the angular part of the lower jaw. The gill-openings are large and extend forward between the branches of the lower jaw to a line with the anterior margin of the eye. The branchiostegal membranes, which are generally extended on twelve flat, sword-like rays, are free, but cross each other in front, when the gill-openings are closed.

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[a] In two of the specimens belonging to the Royal Museum these teeth are wanting.

Here, as in the Mackerels, the pointed shape of the fins indicates a capacity of swift motion and sudden changes in its direction. The pectoral fins are set high, almost vertically, and obliquely pointed. Their length, which at the end of the strictly juvenile changes of growth is about equal to the length of the postorbital part of the head, subsequently shows relative diminution, but still measures about 90 % (sometimes 80 %) thereof. The distance between the front end of the insertion of these fins and that of the ventral fins is from about 5 to $5\,{}^{2}/_{3}$ times the length of the former. They contain 13 rays, the uppermost of which is the longest or equal in length to the second ray, undivided and compressed like a sabre. This is also true of the first ray in the ventral fins, which are also pointed[a]. The length of these fins is about equal to the height of the dorsal fin. They are moved forward during growth, the distance between them and the tip of the lower jaw decreasing in proportion to the length of the body, while on the other hand, the distance between them and the beginning of the anal fin increases. At the end of the true juvenile changes of growth the former distance is nearly ${}^{2}/_{3}$ of the length of the body, but in specimens 7 or 8 dm. long only about 60 % thereof. The latter distance simultaneously increases from about 11 % to 14 or 15 % of the length of the body. The dorsal and anal fins are almost alike in shape; but the former is always somewhat shorter and lower than the latter, and the distance between its beginning and the vertical line from the beginning of the anal fin is generally about equal to that between its termination and the vertical line from the end of the latter. The distance between the dorsal fin and the tip of the lower jaw varies, after the end of the juvenile changes, between 79 and 75 % of the length of the body. The distance between its end and the beginning of the caudal fin is somewhat greater than the length of the pectoral fins, varying between about 64 and about 52 % of the length of the fin itself. This is due to the fact that the length of its base undergoes even relative increase from about 11 % to about 13 % of that of the body. The first two rays are undivided, the second being about twice as long as the first, and the longest in the whole fin. The pointed lobe at the beginning of the fin, the height of which is generally equal to the length of the ventral fins, is formed by the first six rays; the other rays are generally of uniform height, though a slight elongation may be observed in the middle ones. This is never so marked, however, as the posterior elevation of the dorsal fin in the Mediterranean *Ramphistoma imperiale* (*Cantrainii*). On account of the changes of growth in the dorsal fin the beginning of the anal fin may sometimes lie vertically below that of the dorsal fin, as in our largest specimen; but the base of the anal fin is always longer than that of the dorsal, varying between about $12\,{}^{1}/_{2}$ % and about 14 % of the length of the body, and the distance between it and the caudal fin is less than the length of the pectoral fins. In adult specimens the caudal fin is deeply forked, with pointed lobes, the length of which is about ${}^{1}/_{10}$ or ${}^{1}/_{11}$ of that of the body. The extreme end of each lobe is formed by the outermost branched ray, which in full-grown specimens, however, is hardly any longer than the longest (hindmost) supporting ray. We have always found the number of branched rays in the caudal fin to be 13[b]. The vent, which is situated just in front of the anal fin, is noticeable for its somewhat considerable size.

The scales of the body are very thin and for the most part deciduous; but on the back and head they are hard to detach, and extend forward over the nasal region and the base of the upper surface of the intermaxillary bones. Even on the preorbital bones small scales may be found, and on the cheeks and opercula they are distinct. On these parts of the body, however, all the scales are small; but on the ventral sides, interspersed among the small scales, we find larger ones, almost thrice the size of the former and serving as a kind of foundation for them. The vertical diameter of these large scales is greater than the longitudinal, sometimes twice as great, and sometimes measures as much as half the longitudinal diameter of the eye. Their structure is the same, however, as that of the small scales: they are thin and transparent, with distinct, concentric rings formed during growth, but without radiating striæ or curves. The scales in the rows which coast the lateral line are somewhat thicker and curved, while those of the lateral line itself are pierced in the usual manner. Where this line runs on each side along the belly, rising slightly outside and above the ventral fins, the belly thus acquires a somewhat raised longitudinal margin.

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[a] Among the five branched rays in these fins the inner ones, in particular, have a well-developed dermal fold between them: and as a similar fold also follows the inner side of the innermost ray, we may easily fall into the error sometimes committed, of stating the number of these rays at 6 instead of 5.

[b] According to LILLJEBORG the number of these rays is 14, according to DAY 13 or 14, and according to KRØYER 17. EKSTRÖM gives 13.

The transparency of the scales displays the Mackerel-like coloration of the body in all its brilliancy. The back is greenish, with a steel-blue lustre of varying intensity, darker, nearly black, at the middle, and forming a longitudinal band at the boundary between it and the sides. The sides are silvery, and the under surface of the belly white. The dorsal and caudal fins are of the same colour as the back, shading either into green or blue, the latter fin, however, with a dash of gray. The pectoral, ventral and anal fins are of the same colours as the sides and belly, light gray or yellowish white. The iris is silvery white, with a more or less distinct dash of gold.

The true geographical range of the Garpike extends from the neighbourhood of Trondhjem in Norway southwards throughout the Mediterranean: it occurs in the Black Sea as well as in the Baltic. North of Trondhjem it is sometimes found, it is true, up to the extreme north of Norway; but there, as on the coast of Iceland, it is of rarer occurrence. In the north of the Baltic too, it becomes rarer. On the coast of Scania and off Kiel it is common, but is found only in small numbers on the Prussian coast (Benecke). Lindström assigns it to Gothland and Ekström to the island-belt of Mörkö, while Lilljeborg obtained specimens of an average size from Roslag. According to Malmgren and Mela it ascends the Gulf of Bothnia up to Qvarken and wanders eastwards half-way up the Gulf of Finland; but in both these arms of the Baltic it is rare. On the west coast of Sweden, however, from the Sound up, as well as on the Danish coast and off the south and central parts of Norway, it appears close in shore, in large shoals, every year. Even in Sweden it sometimes enters the mouths of rivers or penetrates higher up the stream: Nilsson states that in the River Höje it has been taken as far up as Värpinge, near Lund[a].

No less active than voracious, the Garpike is one of the few fishes that really make their presence known at the surface of the sea, where it appears in large numbers, whether it be in order to spawn, in chase of its prey, or itself in flight from some enemy. "There are times also," says Couch[b], "when the sea is calm and smooth, that it may be seen engaged in solitary amusement at the surface, or perhaps many together, by leaping again and again over some floating object, as a rod or straw, or it may thrust itself bolt upright out of the water, to fall back again in an apparently clumsy manner. It is an amusement with fisherboys to throw some slender stick to the Garfish, when it will execute a variety of evolutions about and over it as it floats." In pursuit of some little fish at the surface, or when hunted itself, it may be often seen leaping out of the water in the chase. "We were fishing yesterday," writes Cornish[c], "off Lamorna, in about eight fathoms of water, and close in shore, when our attention was attracted by a noise in the water near us. It was caused by a large shoal of gerricks scudding very rapidly on the surface of the water. The appearance was as though the fish were actually swimming on the surface, with the larger portion of their bodies in the air, but this was probably an optical delusion, caused by the constant succession of fish coming to the surface. They passed close by us, less than five fathoms from the bows of our boat, and as they passed we saw in chase of them certainly one, and probably more than one, large Tunny ("albacores," as they call them here). The tunnies were dashing about after their prey, almost on the surface of the water, and removed all doubt as to their identity by more than once springing clean out of water close by us." Schagerström describes a similar scene in the Sound[d]: "It is a really fine sight on a clear day to see a large shoal of these fishes hunted by Tunnies[e]. The Garpike keep to the surface, and often leap a foot or two out of the water." When the Garpike has taken the hook (which must be offered it at the surface and constantly kept in motion), "it does not seek," says Couch, "to escape by darting away, but, as if conscious only of the annoyance from the restraint of the line, it will mount to the surface, even before the fisherman discovers that he has had a bite; and there, with its body partly out of the water, it struggles with the line in a variety of active contortions."

We have every proof that the Garpike leads the life of a surface-fish, and in this respect it reminds us of the Flying-fish. "Sometimes," says Kroyer[a], "it even happens that a Garpike leaps into a boat." For a voracious fish, as we have stated above, the offensive and defensive weapons of the Garpike are of singular nature. Though both jaws are elongated, the lower jaw, with its soft and somewhat flexible tip, can scarcely serve under ordinary circumstances as a weapon of attack, a function which must rather belong to the upper jaw. Whether the Garpike is able to swallow the large fish, no smaller than itself, which it has sometimes been seen to attack, is as yet unknown. The fishermen declare that the Garpike sometimes engage in war among themselves, and do not escape easily, as is shown by the scars on their bodies. Day states, on Mr. Dunn's authority, that the latter once received a Mackerel that had been transfixed, just below the pectoral fin, by the beak of a Garpike, which had broken off short in the struggle. A similar occurrence is mentioned by Couch[b]. Mr. Clogg[c] tells us of a fisherman who met with much difficulty in taking a Salmon-peal from his net. On searching for the cause he saw what he supposed to be the ends of a stick protruding on each side of the fish, but on extracting and examining it he found it to be the under jaw of a Garpike, known locally as a "longnose." "There can be no doubt," he says, "the garfish attacked the peal, rushing on it with sufficient force to thrust the lower jaw completely through the peal, which must have broken off either by the force of the blow or by the struggles of each fish to free itself. The peal, which weighed nearly four pounds, was struck behind and just above the pectoral fin, the jaw of the garfish thus passing through the thickest part of the peal, requiring — if we compare the weight of a swordfish to that of a garfish — even greater velocity of attack in the latter to cause so great a penetration through a fish than it would in the former to penetrate many inches of oak-plank." Just as it has been shown that the Swordfish attacks objects that can do it neither good nor harm, and that it probably does so by mistake, it seems also likely that these accounts of the Garpike may be explained in the same way. The Garpike, however, attacks its actual prey in the same manner, pierces it with one of its jaws and then shakes it loose, or seizes it between its jaws and worries it to death by means of the powerful movements of its head, or carries it for some time in its beak before devouring it.

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[a] In Holland the Garpike enters the branches of the Rhine; see Tijdschr. Nederl. Dierk. Vereen., Suppl., Deel II, p. 109.

[b] *Fish. Brit. Isl.*, vol. IV, p. 147.

[c] *Zoologist*, vol. XXIII, 1865, p. 9814.

[d] Phys. Sälls. Tidskr. 1838, Häft. III, p. 297.

[e] Schagerström here writes *Delphinus delphis;* but we learn from Kroyer that by *springare* the fishermen of the Sound mean the Tunny.

The food of the Garpike is composed chiefly of young Herrings, Sticklebacks and other small fishes, crustaceans and other minute marine animals. Couch found Herrings in its intestinal canal, Ekström a large quantity of Three-spined Sticklebacks and, still oftener, of *Idothea entomon*, a Gammarid common in the Baltic. Lilljeborg found the stomach to contain small fishes and ants, Olsson[d] small fishes, among them Sand-eels, and Gammarids, beetles and flies. The Garpike digests its food quickly, and in spite of the simplicity of its intestinal canal extracts no small amount of nutriment from the food. The abdominal cavity is sometimes full of fat, though the flesh appears somewhat dry.

The Garpike spawns in spring and the early part of summer, from April to June. The older fishes spawn first. At this period it approaches the coast[e]. "In the middle of May," says Ekström, "this fish begins to spawn in the island-belt of Mörkö. The males and females then ascend together in large shoals to spots along the coast where the water is shallow. I have never seen the roe of this fish in the water; but it is probably deposited on the weeds, for it is always on a weedy bottom that the Garpike is found during the spawning-season. The roe I have found on cutting open specimens ready to spawn, was fine and greenish yellow in colour." According to Benecke the eggs are from 3 to $3^1/_2$ mm. in diameter, the surface being covered with numerous hair-like filaments, some of them 1 cm. long, by means of which they anchor themselves in the manner we have described above. They develop so quickly, and the fry grow so fast, that as early as August we may find small Garpike 150 mm. long (Malm), and "during the summer" of 1837 Fries took a specimen 170 mm. long. In the Cattegat the Garpike stays close in shore for some time after the end of the spawning-season, to feast on Herring-fry and Sand-eels; but those that spawn in the

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[a] The same statement is made by Faber, *Fische Islands*, p. 156.

Land and Water, 8th December, 1866.

[c] *Zoologist*, vol. XXXII, Sept. 1874, p. 4160.

[d] Lunds Univ. Arsskr. VIII, Afd. 3, No. 7. p. 6.

[e] In most localities the Garpike heralds the approach of the Mackerel, which soon afterwards appear off the coast with the same object. In England it is locally known by the name of Mackerel-guide.

According to Nilsson there is a fairly general superstition, in the south of Sweden at least, that when many Garpike are caught in spring, the summer will be very dry — and it is also believed, he says, that during the following year prices are always high.

Sound, after depositing their spawn, pass into the Baltic, whence they return in autumn in splendid condition.

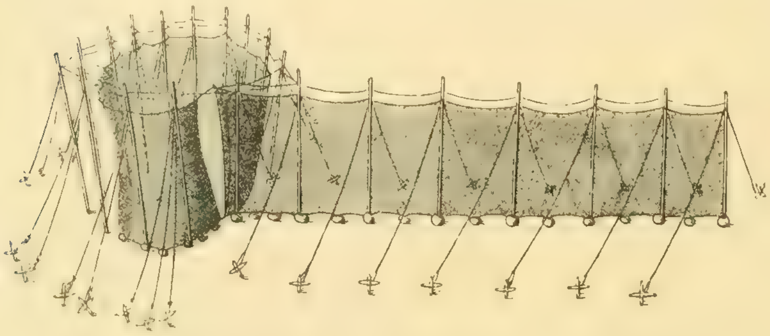

Fig. 93, *a*. *Bottom-net* (Sw. *Bottengarn*) from the Sound.

The fishery is carried on in accordance with these circumstances. Though the flesh of the Garpike is somewhat dry, as we have mentioned, its flavour, no less than its colour, resembles that of the Mackerel; and though it is disliked by many people on account of its green bones and the rank smell of new-caught specimens, it forms an excellent dish, boiled or smoked, and is a catch by no means to be despised. In the open sea it is often taken in the Mackerel-nets. During the spawning-season it resorts to the fishing-grounds on the coast, and is then taken in the common seine. In the Sound, during the greater portion of the autumn, Garpike are taken in "bottom-nets" (fig. 93, *a*), stationary tackle, a kind of stake-net, constructed on the principle of the common traps, but provided with a ground-net for the chamber, which is lifted up in examining the net. The Garpike is also taken on the hook, though not very often in Scandinavia. According to Blanchère[a] this fishery is carried on on the French coast during the Mackerel season, with the same bait and in the same manner. Nordmann states that in the Black Sea the Circassians and Abkhasians catch these fish with bright-coloured balls of raw silk, which they fasten to the lines instead of bait. The Garpike is attracted by the colour, entangles its teeth in the threads, and is thus captured. On the coasts of Germany, according to Bloch, the Garpike in former times was mostly speared by torchlight.

In many countries the Garpike-fishery is very valuable. In London, where in spring large quantities of Garpike are often brought to market, its cheapness then renders this fish a common article of food, according to Yarrell. In Denmark and Scania this is also the case in spring and autumn[b]. In the Cattegat the largest catches are made off Læsö[c]. A large proportion of the Garpike taken here are conveyed to Gothenburg; and in 1856 Malm[d] estimated that the supply of Garpike during the spring and summer, chiefly from this island, numbered about 1,188,600, with a value of about £2050 (37,000 Swedish crowns). In Holland, where the Garpike is taken in great abundance, but held in low esteem as an article of food, it is employed principally as bait, especially during the Cod-fishery.

Genus SCOMBRESOX.

Both jaws (the under one most so) elongated into a narrow and long or at least pointed beak, armed with one or two rows of extremely small teeth. Several finlets behind the dorsal and anal fins. Body elongated and compressed.

The genus *Scombresox*, which, according to Couch, was probably known even to the Greek writers Oppian and Ælian, who are said to have called it Hierax or Hirax (Sea-hawk), received from Rondelet the name of *Saurus*, and in 1803 was introduced into the system by Lacepède under the name of *Scomberesox*. It has subsequently been known by Rafinesque as *Sayris*. The juvenile stage, previous to the elongation of the snout, was named *Grammiconotus* by Costa[e]. Lütken[f] has rendered it a very doubtful point whether more than two species of this genus are known. One of these species, the Pacific *Scombresox brevirostris*, from California, has a comparatively short beak, the lower jaw being of about the same length as the preorbital part of the head, and the upper jaw exactly like that of *Hemiramphus*, and in the adult state[g] thus corresponds to one of the juvenile stages (*b* or *c*) in Lütken's figure (see above, p. 346) of the Scandinavian species,

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[a] *Nouv. Dict. Gén. d. Pêches*, p. 565.

[b] See Schagerström and Kroyer.

[c] See Kroyer.

[d] *Gbgs, Boh. Fn.*

[e] Ann. Mus. Zool. Nap., Anno I, p. 55, tav. I, fig. 4.

[f] Vid. Selsk. Skr., 5 Række, Naturv. Math. Afd., XII, p. 565.

[g] The Royal Museum possesses a specimen 200 mm. long. Peters' type-specimen was of the same length. Jordan and Gilbert, however, state that the species attains a length of about 350 mm.

THE SAURY PIKE OR SKIPPER (SW. MAKRILGÄDDAN[a]).

SCOMBRESOX SAURUS.

Fig. 93.

Both jaws, in adult specimens, elongated into a beak. Length of the postorbital part of the head, in specimens 150 mm. long, about $^2/_3$ of that of the lower jaw, and in specimens 300—400 mm. long, scarcely half or even only about 35 % thereof. Coloration like that of the Garpike, but with a more sharply marked longitudinal band of silvery lustre on the sides just below the back, which is of a lustrous greenish blue.

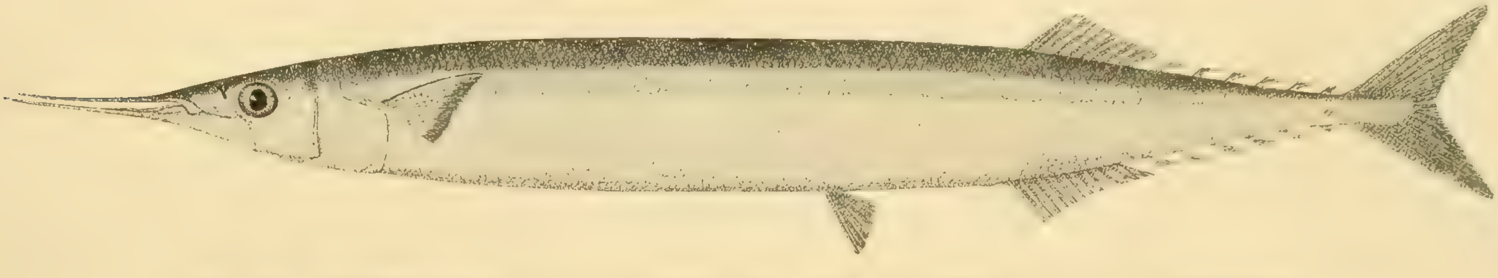

Fig. 93. *Scombresox saurus*, $^2/_3$ of the natural size. Taken at Strömstad in 1878, C. CEDERSTRÖM.

R. br. 13 l. 14: *D.* $\frac{1}{9^{b}-11}$ V l. VI: *A.* $\frac{1}{11-13}$|VI l. VII; *P.* 12 l. 13: *V.* 6; *C.* $x+12$ l. $13+x$; *Squ. lin. lat.* ca 150; *L. tr.* 15 l. 16.

Syn. *Saurus*, ROND., *De Pisc.*, lib. VIII, cap. V; RAY, *Syn. Pisc.*, pp. 109 et 165; *Saury Pike*, PENN., *Brit. Zool.*, 1776, vol. III, p. 284, tab. LXIV.

Esox Saurus, WALB., (ex. PENN.) *Art. Ichth.*, part. III, p. 93; GTHR (*Scombresox*), *Cat. Brit. Mus. Fish.*, vol. VI, p. 257; COLL., Vid. Selsk. Forh. Christ. 1874, Tillægsh., p. 176; ibid. 1879, No. 1, p. 95; MALM, *Gbgs, Boh. Fn.*, p. 555; WINTH., Naturh. Tidskr. Kbhvn, ser. III, vol. XII, p. 46; MOR., *Hist. Nat. Poiss. Fr.*, tom. III, p. 475; JORD., GILB., Bull. U. S. Nat. Mus., No. 16, p. 375; DAY, *Fish. Gt. Brit., Irel.*, vol. II, p. 151, tab. CXXVII, fig. 2; PETERSEN, Vid. Medd. Naturh. For. Kbhvn 1884, p. 159; COLL., N. Mag. Naturv. Christ., vol. 29, p. 110; LILLJ., *Sv., Norg. Fn., Fisk.*, vol. II, p. 456; NYSTRÖM, Bih. Vet.-Akad. Handl., vol. 13, part. IV, No. 4, p. 44.

Scombresox Camperii, LACÉP., *Hist. Nat. Poiss.*, tom. V, p. 345, tab. 6 (p. 235), fig. 3; CUV., VAL., *Hist. Nat. Poiss.*, vol. XVIII, p. 464; KR., *Danm. Fiske*, vol. III, p. 278; NILSS., *Skand. Fn., Fisk.*, p. 358; ID., Öfvers. Vet.-Akad. Förh. 1863, p. 501.

Scombresox scutellatum (specim. jun.) + *Sc. equirostrum*, LESUEUR., Journ. Acad. Nat. Sc. Philad., vol. II (1821), p. 132.

Scombresox Rondeletii, CUV., VAL., l. c., p. 472 — specim. sine vesica aërea.

Scombresox storeri, DEKAY, *N. York Fn.*, part. IV, p. 229, tab. XXXV, fig. 111; STOR., Mem. Amer. Acad. Arts, Sc., n. ser., vol. VI, p. 315, tab. XXIV, fig. 4.

The Saury is very like the common Garpike, in spite of the distinction drawn between them, at the first glance, by the finlets behind the dorsal and anal fins. The body, however, is deeper[c] and more compressed[d], the lateral compression of the belly being particularly strong. The jaws are more slender, somewhat turned up at the tip, and furnished with much weaker teeth of uniform size, which are set in two rows only in the back half of the lower jaw and a corresponding, though smaller, portion of the upper jaw. With this exception the teeth are set in one row. The zigzag bony ridge in the lower jaw, on the other hand, is higher and thicker. The preorbital bone does not cover the lateral parts of the intermaxillaries so completely as in the Garpike, a fairly broad part of these bones, somewhat widened inferiorly, remaining visible when the mouth is closed. The nasal orifice is more compressed and almost T-shaped. The eyes are more oblong[e]. The relative length of the head in full-grown specimens is about the same as in middle-sized specimens of the preceding species. The pectoral fins are somewhat shorter, always distinctly shorter than the postorbital part of the head, and more concave (falciform) at the inferior margin: sometimes, in old specimens, these fins are no longer than the ventral fins. The dorsal and the anal fins are both set farther forward than in the Garpike[a], and are both lower and shorter, being also without the pointed prolongation in front. As a rule, the anal fin is somewhat, though only slightly, the longer; but the difference is so small that we may sometimes reckon the length of each of these fins as equal to that of the postorbital part of the head. The difference may sometimes be increased, however, by the circumstance that the first finlet behind either of these fins still preserves the appearance of a posterior part of the fin, not being separated from it. Just as in the Garpike, the posterior rays of these fins are rather widely separated from each other; but the first ray — a difference of no slight importance — in addition to being the only simple ray in the fin, is also unarticulated, thus being a true spinous ray. The caudal fin is deeply forked, and at the middle of its base the dermal covering extends so far out over the middle rays that only their branches are visible, a result of this being that the number of rays in this fin has sometimes been stated to be considerably greater than is really the case. The number of the branched rays seems to be 12[b] or 13, the latter probably being the normal number in this species as in the Garpike. The ventral fins occupy about the same position in the abdominal region[c] as in the Garpike; but as the relative length of both the abdominal part[d] and the head is somewhat less than in the latter species, the ventral fins, as well as the dorsal and anal fins, assume a more forward position on the body[e]. The vent is not so large or so prominent as in the Garpike; but here too, in a triangular cavity behind it, we sometimes find (in the males?) a small genital papilla. The scales are of the same thin texture as in the Garpike and are also deciduous, being larger on the lower portion of the sides than on the upper, but of more uniform size than in the preceding species. As the belly is much more compressed underneath than in the Garpike, the two lateral lines are much nearer each other: with this exception the course of these lines is the same, ending at the second or third of the anal finlets, counting from behind.

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[a] NILSSON, *Skand. Fauna*, l. c.

[b] Sometimes 2, according to LÜTKEN.

[c] In the Saury the greatest depth of the body varies between $9^1/_2$ and 12 % of the length of the body.

[d] The greatest breadth (thickness) of the body (across the occiput) varies between about 47 and 53 % (according to KRØYER sometimes 57 %) of the greatest depth thereof.

[e] The longitudinal diameter of the eye in full-grown specimens is between about $^2/_5$ and $^1/_3$ of the length of the postorbital part of the head.

The changes of development undergone by the Saury are essentially the same as those of the Garpike, but of much later occurrence. The clearest illustration of this is given by the above figures borrowed from Lütken. The original of fig. *c* (*Scombresox*, p. 346) was about twice as long as that of fig. *β* (*Ramphistoma*), of fig. *d* (*Scombresox*) about equal in length to that of fig. *γ* (*Ramphistoma*). The *Hemiramphus* stage is thus persistent for a much longer period in the Saury than in the Garpike. On the other hand we find that, when once the elongation of the jaws has begun, the difference in their length is never so great as in the latter species.

The Saury Pike is a more pelagic fish than the Garpike, and a surface fish of a still more distinct character. It is at the surface that it spawns and passes its time, leaping or even flying still more like a Flying-fish than the Garpike. In the Tropical and Temperate Zones its range extends all round the world: it has long been known in the Mediterranean and the Atlantic; Lütken has shown that it occurs in the Indian Ocean; according to Jordan and Gilbert it is fairly common on both sides of North America; Nyström has found it among the collection of Japanese fishes in Upsala Museum. Like the Garpike, however, when it approaches the coast, it sometimes enters the harbours and the mouths of rivers. It makes annual visits to the English coast, but probably not for purposes of reproduction, for the spawning apparently takes place in the open sea, where the fry have been found in large numbers. It arrives off the English coast, according to Couch, at the beginning of summer, and departs at about the middle of autumn or even as late as the end of November. "The Skippers," says Couch, "are followed and persecuted by the Porpoise, and the more swift and energetic Tunny and Bonito, which appear to devour many of them; and in their eagerness to escape multitudes are seen to mount to the surface, to which the particular construction of the pectoral fin is well fitted to guide them, and there they crowd on each other as they press forward. Under the impulse of terror they spring to the height of several feet — leap over each other in singular confusion, and then again sink out of sight. But the pursuers again shew themselves, and they mount again, and rush along the surface for more than a hundred feet in a continued effort, without the body for a moment being lost sight of, and, as it would appear, by the instant but repeated touch on the water of the pectoral fins and those which lie along the under part of the body." It is from the appearance which it presents at the surface on these occasions, that the English sailors have given this fish the name of Sea-mouse. Often enough it leaps out of the water into a fishing-boat. When it has entered the shallows, it often forgets to retire at the ebbing of the tide; and in the Firth of Forth hundreds of specimens are then picked up on dry land, with their beaks stuck in the sludge. During the Pilchard-fishery it is an unwelcome guest, for the fishermen believe that the Pilchard has a strong dislike to, or perhaps fear of it. We also learn from England that in 1825 numbers of Sauries and Pilchards were together enclosed in a Pilchard-seine; and before it was possible to secure the catch, thousands of the Pilchards had their eyes gouged out by the Sauries, and scores of them were transfixed by their enemies' beaks. These wounds, however, can scarcely be dealt intentionally, for the Saury, which is smaller than the Garpike, and has a still weaker beak, can hardly prey on fishes as large as the Pilchard. Its food is composed of small, or even the smallest crustaceans or Entomostraca, the larvæ of crustaceans and, in all probability, other minute creatures that live at the surface or among the seaweed. We may also infer that small fishes form a part of its food, from the fact that it is sometimes taken on the hook. The Saury itself is good eating. The spawning-season is as yet unknown.

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[a] The distance between these fins and the tip of the lower jaw is between about 70 and 72 % of the length of the body.

[b] Moreau and Day state the number of true rays in the caudal fin at 14, i. e. excluding the two outermost, which are undivided, 12 branched caudal rays. The author, like Lilljeborg, finds the number of the branched rays to be 13.

[c] Somewhat behind the end of the second third of the abdominal region.

[d] We have found the length of the abdominal region in *Ramphistoma belone* to vary between about 46 and 49 % of that of the body, and in *Scombresox saurus* between about 40 and 43 % thereof.

[e] The distance between the ventral fins and the tip of the lower jaw, in the specimens we have examined, has never been as much as 59 % of the length of the body.

Like the Garpike, the Saury wanders far out of its ordinary habitat, but probably not in shoals. Solitary specimens have been taken even in the extreme north of Norway. One of these, 245 mm. in length, was caught during the summer of 1883 off Gjesvær, near North Cape, and is now preserved in Tromsö Museum, which also possesses a specimen 230 mm. long, from Helgeland[a], where it was found on the beach in August, 1877. Previously, about 1850, one or two specimens, one of which, an example 380 mm. in length, is preserved in Christiania Museum, had been taken in Christiania Fjord. The Museum of Copenhagen possesses one specimen, 255 mm. long, from Iceland, three from the Sound, one from the Great Belt (Nov., 1873) and two (Oct., 1886) from Agger on the west coast of Jutland. In Bohuslän three specimens have been taken, one 295 mm. in length, which was forwarded to the Royal Museum in 1878 by Baron CEDERSTRÖM, Ph. D., and two obtained by Mr. C. A. HANSSON, who handed over one of them, 300 mm. in length, to the Museum of Upsala and the other, 165 mm. in length, to the Royal Museum. Both the last specimens were caught in November. A fourth Swedish specimen, 222 mm. long, which was taken in the Sound off Râå, in May, 1862, is preserved in the Museum of Malmo.

The Saury is thus one of the rarest Scandinavian fishes, and consequently cannot be of any special value to the fishermen of Scandinavia. The case is the same along the west coast of the Continent — on the west coast of France, according to MOREAU, this fish is extremely rare. In England, however, and even on the Scotch coast, it apparently occurs in large shoals every year; and it is found oftener than in Scandinavia among the Orkney and Shetland Islands.

Subfamily EXOCOETINÆ.

Intermaxillary bones furnished with a distinct — though sometimes very thin — lip, and articulating by means of nasal processes — which are sometimes very short — with the surface of the front end of the ethmoid cartilage. Maxillary bones free and with movable articulation. Snout short, neither of the jaws being elongated[b].

This subfamily contains the fishes which most strictly deserve the name of *Flying-fish*, most of them having long and highly expansive pectoral and ventral fins, and the lower lobe of the caudal fin considerably longer than the upper. Some fifty species have been distinguished and distributed among three or four genera; but the distinction of the species is still extremely dubious, this being due chiefly to our ignorance of the changes of growth, especially in the coloration. The most important characteristic employed in the definition of the genera, lies in the position of the ventral fins. Each of the two species of which we have the earliest knowledge, has therefore been chosen as the representative of a distinct genus, the one[a] with the ventral fins situated rather far forward and comparatively small, the other, *Exocoetus*, with the ventral fins larger and set farther back. SWAINSON also formed a distinct genus[b] to receive the species that are furnished with barbels under the point of the chin; and BLEEKER established a genus[c] consisting of the species which, on account of the knob-shaped, rudimentary elongation of the lower jaw, seem to form a transition from this subfamily to the preceding one.

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[a] The Norwegian district, not to be confused with Heligeland.

[b] In some forms (*Exocoetus mento* and *Exoc. acutus*), however, according to VALENCIENNES, the tip of the lower jaw is "elongated by a little pointed knob."

None of these genera can strictly be included in the Scandinavian fauna; but in Christiania Fjord a specimen has once been taken of the

GENUS **EXOCOETUS**.

Ventral fins behind the middle point in the distance between the tip of the snout and the base of the caudal fin, and their tip (when folded) extending beyond the beginning of the anal fin. Palate and tongue toothless, or the palatine bones alone slightly rough with small teeth.

Thus defined the genus *Exocoetus* includes the most typical Flying-fishes and the largest number of described species within the subfamily. The name of *exocoetus*[d] originally had reference to a fish that the ancients supposed to creep up on a rock to sleep. We do not know what fish this was — perhaps a Gobioid, as RONDELET[e] supposed; but it was certainly not a Flying-fish, as ARTEDI[f] assumed, and LINNÆUS subsequently took for granted. However, the singular appearance of the Flying-fishes and their valuable flesh must certainly have given them prominence at an early period, and according to SALVIANUS their Greek name was *chelidon*[g], just as the Romans called the genus *hirundo*. The geographical extension of the genus is the same as that of the Sauries, and several species — as clearly defined as our present knowledge of them permits — deserve the name of cosmopolitan in the seas of the Tropical and Temperate Zones.

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[a] *Halocypselus*, WEINLAND, Proc. Soc. Nat. Hist. Bost. VI (1859), p. 385.

[b] *Cypsilurus*, *Nat. Hist. Fish.*, *Amph.*, *Rept.*, vol. I, p. 299, vol. II, pp. 187 and 296. WEINLAND (l. c.) corrected this generic name to *Cypselurus*; and GÜNTHER remarked (*Cat. Brit. Mus.*, *Fish.*, vol. VI, p. 278) that, in certain species at least, the generic character is merely an evanescent character of the young specimens.

[c] *Parexocoetus*, Esp. Exoc., Ned. T. Dierk., III, p. 126, see *Atl. Ichth. Ind. Or. Néerl.*. tome VI, p. 77. BLEEKER has also given the presence of teeth on the vomer, the palatine bones, the pterygoid bones and the tongue as a character of this genus.

[d] ᾿Εξώκοιτος, sleeping out.

[e] *De Pisc.*, lib. VI, cap. XV.

[f] *Gen. Pisc.*, p. 8; *Syn. Pisc.*, p. 18.

[g] Χελίδων, swallow.

THE GREAT FLYING-FISH.

EXOCOETUS VOLITANS.

Fig. 94.

Pectoral fins only slightly (never more than 1/5) shorter than the length of the trunk, the second ray branched, the third ray the longest. Ventral fins inserted in front of the middle-point of the trunk (nearer to the head than to the base of the caudal fin), and their tip (when folded) extending to about the end of the base of the anal fin. The dorsal fin begins somewhat in front of the perpendicular from the vent, its height in front (the length of the second ray) being equal to that of the preoperculum (or the total height of the operculum and suboperculum). Beginning of the anal fin situated below the 5th, 6th or 7th ray of the dorsal fin, its base much shorter than that of the dorsal fin[a] *and the height about 2/3 of the base. Length of the upper lobe of the caudal fin from the base of the first supporting ray*[b] *about equal to that of the head, and the lower lobe half as long again. Coloration like that of the Herring or Gray Mullet, lustrous steel-blue on the back, silvery on the sides and belly; pectoral fins bluish gray, in young specimens darker, more bluish on the inside, with white margin and in young specimens with a white transverse band; dorsal fin whitish gray, caudal fin brown, ventral and anal fins whitish blue.*

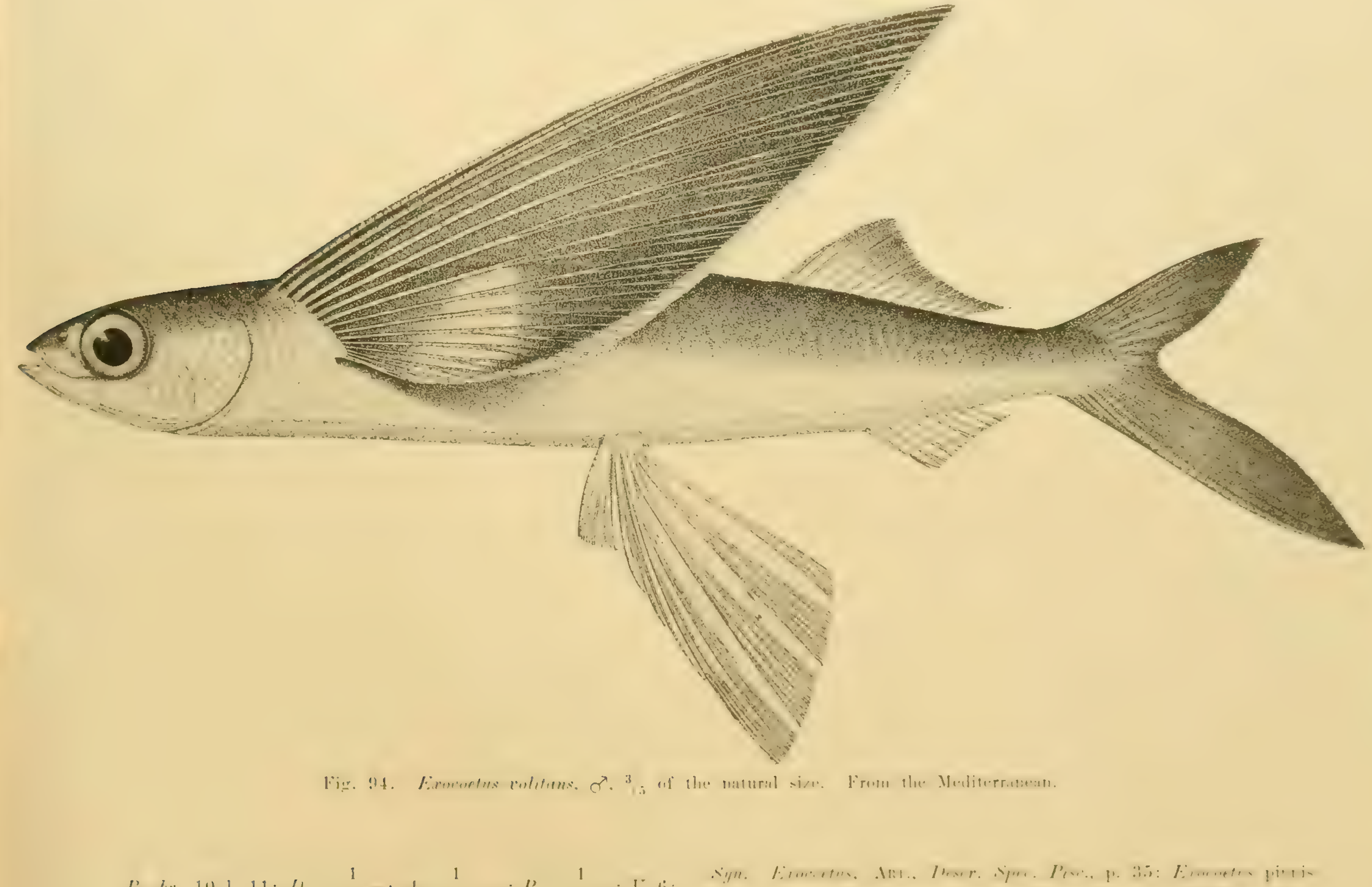

Fig. 94. *Exocoetus volitans*, ♂. 3/5 of the natural size. From the Mediterranean.

R. br. 10 l. 11; *D.* $\frac{1}{10-12}$; *A.* $\frac{1}{8-10(?)}$; *P.* $\frac{1}{14-17}$; *V.* 6; *C.* $x+13+x$.

Syn. *Exocoetus*, Art., *Descr. Spec. Pisc.*, p. 35: *Exocoetus* pinnis ventralibus longioribus: . . . Gron. *Zoophyl.* (1763) p. 116: *Exocoetus quadriremis*, Gron. mss. ed. Gray, p. 145.

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[a] In young specimens about 5/9 of the base of the dorsal fin, in older ones about 3/4 thereof.

[b] According to Steindachner.

Exocoetus volitans, Lin., *Syst. Nat.*, ed. XII, tom. I, p. 520 (ex. Gron. *Zooph.*); Cuv., Val., *Hist. Nat. Poiss.*, vol. XIX, p. 83, tab. 559; Steind., Stzber. Akad. Wiss. Wien, Math. Nsturw. Cl., LVII, i, 1868, p. 734; Ltkn, Vid. Meddel. Naturh. For. Kbhvn 1876, pp. 393 et 401; Mor., *Hist. Nat. Poiss. Fr.*, tom. III, p. 481; Day, *Fish. Gt. Brit., Irel.*, vol. II, p. 154, tab. CXXVIII.

Exocoetus exiliens, Bl., *Naturg. Ausl. Fisch.*, part. IX, p. 10, tab. CCCXCVII; Cuv., *Règn. Anim.*, ed. 2, tom. II, p. 287; Swains., *Nat. Hist. Fish., Amph., Rept.*, vol. II, p. 296; Couch, *Fish. Brit. Isl.*, vol. IV, p. 128, tab. CCVII; Lillj. (*exsiliens*), *Sv., Norg. Fn., Fisk.*, vol. II, p. 466.

Exocoetus (*volitans?*), Coll., Forh. Vid. Selsk. Christ. 1874, Tillægsh., p. 177; *Exoc.* sp. n. ?, Ltkn, l. c., p. 403; Coll., Forh., l. c., 1879, No. 1, p. 95; Malm, *Gbgs, Boh. Fn.*, p. 555.

Obs. The first to distinguish between more than one species of Flying-fish within this family was Gronovius, and the first to give systematic names to the two species which this author had established, was Linnæus, who had previously united them both under the name of *volitans*. Linnæus made the mistake, in the twelfth edition of *Systema Naturæ*, of allowing his original description (in Balk's thesis: *Mus. Ad. Frid.*, p. 42 and in *Amoen. Acad.*, vol. I (1749), p. 320) of *Exocoetus* (*Halocypselus*) *evolans* with shorter ventral fins to be included in the list of synonyms of *Exocoetus volitans* instead of *Exocoetus evolans*, to which species according to Lilljeborg we should refer the type-specimen in Upsala Museum. However, this cannot give rise to any ambiguity, for it is evident that Linnæus grounded his opinion chiefly on the distinction drawn by Gronovius. It is less advisable to follow Bloch, and adopt for *Exocoetus volitans* the specific name of *exsiliens* from Linnæus's *Mantissa Plantarum* 1771, p. 529, for in this passage Linnæus describes a young Flying-fish, as yet of doubtful species, "with the 1st and 2nd rays of the pectoral fins short," a character which, up to the present at least, we have no right to regard as evanescent and belonging to young specimens. With respect to the limitation of the species, it is evident from the above diagnosis and fin-formula that we regard it as identically the same as Valenciennes' *Exocoetus lineatus* (Cuv., Val., *Hist. Nat. Poiss.*, XIX, p. 92), the chief distinction between which and *Exoc. volitans* is said to lie in the somewhat greater number of rays in the anal fin (10 according to Valenciennes; 10 or 11 according to Günther, *Cat.*, p. 287). Lütken has shown that the white transverse band on the pectoral fins may also occur in *Exoc. volitans*. Whether this species is distinct from Ranzanis' *Exoc. bahiensis* (see Bleeker: *Atl. Ichth. Ind. Or. Néerl.*, tome VI, p. 71, tab. CCXLIX, fig. 2), is a question that must be settled by a more minute investigation of the point whether *Exoc. volitans* is always without the small teeth on the palatine bones, and whether they are constant in *Exoc. bahiensis*.

The Great Flying-fish may well be regarded as the most pronounced example of those singular habits which have given the genus its name. It is no better known than its kindred species; but it is probably the commonest, at least in the Atlantic — and perhaps in the Mediterranean, where however, according to Giglioli[a], *Exocoetus Rondeletii*, a near relation, is commoner. Most of the observations of Flying-fishes the species of which has not been fixed, probably refer either to this species or to *Halocypselus evolans*, also a common species. In size too, it stands first: the Royal Museum possesses specimens taken near St. Helena, which measure between about 48 and 55 cm. in length to the end of the inferior lobe of the caudal fin.

Much has been written of the flight of the Flying-fish; and we have ascertained, chiefly from Möbius[b], that it is quite different from the flight of birds or insects or the fluttering of a bat, and more closely resembles the leaping movements made through the air by the Flying Squirrels or the Flying Lizards (Dragons). By the help of the large and strong lateral muscles of the body the fish attains the speed of an arrow, which it maintains above the water, slackening, of course, towards the end, and thus traverses a distance of from 100 to 150 metres through the air in less than 20 seconds[c]. At the same instant as it leaves the surface of the water, the pectoral and ventral fins are expanded. It supports itself principally on the former fins, but almost passively, the wind and the pressure of the atmosphere bearing the fish along without any exertion on its own part, save that needed to keep these fins expanded. There is no independent motion of these fins, according to Möbius; but when the wind blows in a direction exactly parallel to their plane, the hind margin flutters, like the sails of a boat in stays. The Flying-fish cannot steer an independent course[d], according to Möbius, the direction of its flight being fixed by the impetus once gained; and when the speed slackens, we may see its course changed by the wind, when the latter is not dead ahead, for some seconds before the fish falls back into the waves. According to Möbius the fish is hardly able to rise or descend at will, and when it is seen moving up and down along the waves, this is probably nothing more than the effect of the current of air that rises from the surface, and is formed in the trough of the waves (fig. 95) just as a stream eddies when it passes a promontory, or from the same cause as that from which the flame of a candle is attracted towards a surface, if we blow straight towards that surface through a tube, the end of which is beside, but behind the candle.

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[a] Espoz. Intern., Pesca, Berlino 1880, Sez. Ital., Catal., p. 103.

[b] Zeitschr. f. Wiss. Zool., 30 Bd, Suppl., (1878), p. 343.

[c] According to Möbius the flight seldom lasts longer than 10 or 15 seconds.

[d] Each ray in the pectoral fins, with the exception of the first two, in the case of which the sinew of the extensory muscles is common, is furnished, as is well known, with a distinct double pair of muscles. L. Agassiz, who during his voyage to Brazil in 1865, devoted particular attention to the habits of the Flying-fishes in the Atlantic (see *A Journey in Brazil*, p. 522), denies that the Flying-fish is entirely destitute of the power of altering the plane of the expanded fins by means of these muscles and thus rising or falling during its flight, or that it is quite unable to change the direction of its course by bending its body. Even Möbius acknowledges that it often happens that Flying-fish which are just above the surface, alter their course by means of the inferior lobe of the caudal fin, which then hangs down in the water.

In order to facilitate its flight the Flying-fish has several peculiarities of structure. Thus we first observe the advanced development of the pectoral fins and the shape of their rays. The first ray, which has to divide the air, is sharply compressed in the plane of the fin as in the two preceding genera; but the rest of the rays are compressed in the opposite direction or rather strengthened in their proximal part (the part nearest the insertion) by a downward (when the fins are at rest, outer) edge along the anterior (when the fins are at rest, superior) margin, the section of these rays in the proximal (inner) part of the fins thus forming an angle opening backwards (when the fins are at rest, downwards). The fin-membrane is attached to the posterior (when the fins are expanded, upper) margin of the rays; and the base of the pectoral fins, which, when the fins are at rest, runs upwards in front and downwards behind, assumes an almost horizontal direction when the fins are expanded, as the anterior (upper) rays are drawn downwards at the base, the fish thus resting on that side of the fins which was formerly the exterior. On the under surface of the expanded fins a deep groove, opening posteriorly and inferiorly, is thus formed between each pair of rays; and it is in these grooves that the upward current of air we have just mentioned, plays its part in lifting the fish.

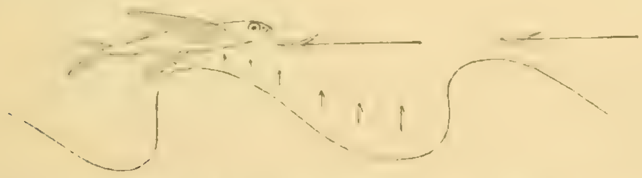

Fig. 95. The lifting of the Flying-fish by the wind, the direction of which is shown by the arrows. After MÖBIUS.

The muscles of the pectoral fins serve chiefly to expand them. They also assist to retain them in the expanded position; but this object is also promoted by the current of air itself, and the rays are kept in position not only by the fin-membrane but also by special ligaments, which cross from one ray to another in the proximal part of the fin. Thus any extraordinary strength — such as would be necessary if the flight were a true one, accompanied by the flapping of the wings — is scarcely needed, and the muscles of the pectoral fins are hardly any thicker than in the generality of Teleosts. These muscles are also arranged in the usual way, in two layers, a superficial and a deeper, on each side of the shoulder-blades and coracoid bones. The common extensory muscle of the two first (uppermost) rays, however, has a long surface of origin at the bottom of the clavicular groove, and has its sinew inserted under a transverse band like a roller, which joins the shoulder-blade to the clavicular bone. Still, the lack of any extraordinary degree of thickness in these muscles is compensated, as in the two preceding genera, by their extension. Their surface of origin, the shoulder-girdle proper — the clavicular bone, the shoulder-blade and the coracoid bone, especially the last of these three — is also extraordinarily large here as in *Ramphistoma*.

The strength required to produce the great speed is given by the large lateral muscles of the body; and their surfaces of origin in front — the occiput and the anterior vertebræ — are of the type we have attributed above to all the Synentognates. Their points of insertion on the last caudal vertebræ are also strengthened. Here, as in the Garpike — and we have observed similar formations in the majority of the Mackerels — we find on each side of the last caudal vertebra a strong, projecting, osseous knob; and in the Flying-fish the upper spinous processes of the last six or seven caudal vertebræ are also longitudinally extended and contiguous.

In the Great Flying-fish and its kindred species the ventral fins also help to increase the width of the fish, and thus also increase the size of the column of air that supports it. Their first ray is compressed and sharp, but repeatedly branched. The second ray resembles the first, but is considerably longer; and the third ray is the longest of all.

As a counterpoise to the weight of the great mass of muscles the Flying-fish is furnished with an extraordinarily large air-bladder, which occupies the greater portion of the abdominal cavity (fig. 96), and is continued behind within the closed hæmal arches of the caudal vertebræ. In the air-bladder of the Flying-fish HUMBOLDT found a strikingly small quantity of oxygen[a].

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[a] 0·04 oxygen, 0·94 nitrogen and 0·02 carbonic acid gas; see *Reise Æq. Geg.*, I, p. 309.

whereas in other fishes, we need hardly say, this gas almost entirely fills the air-bladder.

Möbius also observes that these fishes are assisted in their flight by the flat shape of the belly, where the lateral lines, which are raised as in the preceding genus, follow the ventral margins. The lateral lines thus, to a certain extent, increase the width of the bearing surface. The well-developed palatal curtains or transverse dermal folds in the mouth behind the margins of the upper and lower jaws, are also of service, for they retain the water that is enclosed in the cavity of the mouth, thus keeping the branchial lamellæ moist during the passage of the fish through the air.

In many cases fear is probably the first cause of the aerial flight of the Flying-fish: as we have just observed with respect to the Saury, the Flying-fish also seeks refuge in the air from its pursuers, especially the Dolphin-fishes (*Coryphæna*) and Bonitos, or sometimes springs up in terror before the bow of a vessel under way. Often, however, this habit is due to the same instinct that impels the Garpike to leap out of the water as if in sport; and like other fishes that are closely packed in shoals, they often leap in order to escape the crush or to pass one another. They appear on the wing oftener in stormy weather or a steady breeze than in a dead calm. They generally keep only a few feet above the surface; and when they rise higher, as in the cases where they have fallen on the deck of a vessel as much as 5 metres above the water, this is also due, says Möbius, to the influence of the air-currents (fig. 97). The Flying-fish always come on board on the windward side in a fresh breeze and, in most cases, at night, when in spite of their large eyes they cannot see the ship and avoid it. On the windward side of vessels that have sailed during the night through some part of the ocean where Flying-fish abound, spots of blood and the scales of Flying-fish are often found in the morning; and when the sailors swab the decks, they sometimes come across no small numbers of Flying-fish, a welcome and agreeable change in the seamen's fare. Some of the Flying-fish have thus been dashed against the vessel's side in their rapid flight and killed: but others have been borne over the bulwarks by the current of air that rushes up the windward side of the vessel, and have fallen on deck.

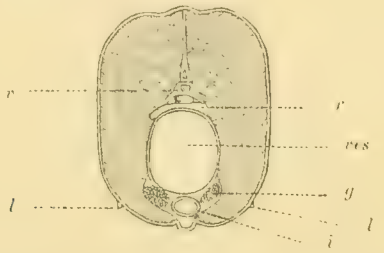

Fig. 96. Transverse section of a Flying-fish: *v*, vertebræ; *r*, kidneys; *ves*, air-bladder; *g*, organs of generation; *l*, lateral lines; *i*, intestine. After Möbius.

The small jaw-teeth of the Flying-fish show that its food must consist of small, weak marine animals of the lower classes. Their pharyngeal apparatus resembles that of the Garpike, there being two upper pharyngeals on each side, the posterior (larger) pair closely united at the mesial line of the palate, and one triangular lower pharyngeal pointed in front, all closely set with cylindrical, obtusely pointed teeth. The gill-rakers are also like those of the Garpike, the outer row on the first branchial arch being thickly set and setiform, and the inner row verrucose and more scattered, like both rows on the other branchial arches. The gill-openings are large, but close firmly and tightly: the branchiostegal membranes are entirely separate, but the left closely covers the right in front.

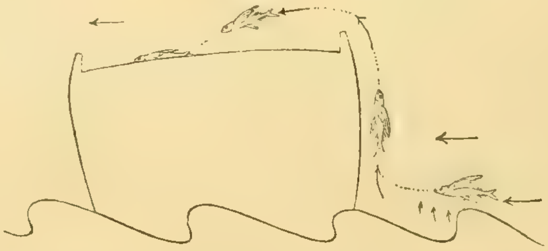

Fig. 97. Flying-fish lifted by the wind and cast on the deck of a vessel, which is shown in transverse section. After Möbius.

Little is yet known of the propagation of the Flying-fishes. Their eggs, like those of the Garpikes, are superficially furnished with filiform appendages. Mathew[a] supposed that the spawning took place and the eggs were developed in the open sea, since he had found young Flying-fish, less than 3 cm. long, leaping on the water, like grasshoppers on land, thousands of miles from the nearest coast. Saunders[b], on the other hand, found Flying-fish (he is also silent as to the species) crowding in to deposit their eggs in rocky crevices and holes under the water, on the Chincha Islands off the coast of Peru. This was at the end of

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[a] Zoologist, 2 ser., vol. VIII (1873) p. 3739.

[b] Ibid. 1874. p. 3838.

March, the season which in the Southern Hemisphere corresponds to our autumn; but according to RISSO[a], the Great Flying-fish of the Mediterranean has its ovaries full in spring.

Exocoetus volitans is a rare species even on the west coast of France, though even there it has long been known, as in his time DUHAMEL[b] received a specimen 43 cm. long, from the English Channel. On the south coast of Ireland and in the Bristol Channel it has been observed somewhat oftener, even in shoals. It is said to have been taken once in the Irish Sea, north of the Isle of Man; but it can scarcely be stated to occur further north on the coast of Great Britain. Still, a specimen about 32 cm. long, according to ESMARK[c], was caught "in a net off Moss at the head of Christiania Fjord, about 1850." The specimen is preserved in Christiania Museum, but is somewhat damaged. LÜTKEN, who was enabled to make a careful examination of this specimen, fixes its species as most closely approximating to *Exocoetus bahiensis*, though he is unable to refer it with certainty to any of the species yet described. LILLJEBORG unhesitatingly refers it to *Exocoetus volitans* (*exsiliens*).

HETEROSOMATA[d].

Malacopterygian Eleutherognates in which at least the orbital region and the mouth are unsymmetrical in the adult state, with both eyes set on the same side of the body.

"Scarcely any other animal form," wrote SUNDEVALL in the first edition of this work, "is so sharply defined by its characters and external appearance as the *Flatfishes* . . . They are characterized by their broad, strongly compressed body, with the dorsal and anal fins occupying almost its whole length, and especially by the fact that both eyes are set on the same side of the head. The skull is so twisted that the eye on one side has been removed to the other. Thus the Flatfishes in their normal state are of a structure that in all other animals would be an extremely remarkable monstrosity, and if they were unusual, we should undoubtedly regard them as the most wonderfully formed of all creatures; but now that we see this animal form so often, it generally excites but slight attention. A Flatfish whose eyes were situated like those of other animals, would be a monster . . . In spite of this deformity of the head, however, the cranial bones are almost exactly the same as those of other fishes, being abnormal only in shape and position. In the other parts of the body, too, there is a certain lack of symmetry, though to a much more restricted extent. The mouth is always somewhat awry, and the teeth different on each side, being often wanting on the upper or eye side; the pectoral fin on the under or blind side is smaller; the vent is turned towards the same side etc. But the most striking difference between the sides is that the eye side is coloured, generally with a dark, brownish tint, and the blind side white. This peculiarity, as well as the position of the eyes, is very nearly connected with the singular manner in which these fishes move. They swim lying flat on one side, with the blind side turned towards the bottom, the eyes and the more developed colour being turned upwards to the light . . . Sometimes, however, we meet with specimens in which the blind side is spotted or partly of the same colour as the eye side."

This want of symmetry in the Flatfishes has been a subject of investigation for many naturalists of recent times. VAN BENEDEN[e], MALM[f], STEENSTRUP[g], TRAQUAIR[h],

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[a] *Eur. Mér.*, tome 3, p. 446.

[b] *Tr. d. Pêches*, part. 11, sect. 3, p. 480, tab. XXII, fig. 2.

[c] See COLLETT, l. c.

[d] Family *Heterosomes*, DUM., *Zool. Anal.* (1806) pp. 119 and 133; *Ichth. Anal.* (1856) p. 354. Order *Heterosomata* in COPE, Trans. Amer. Phil. Soc. Philad., n. ser., vol. XIV (1871), p. 456.

[e] Bull. Acad. Roy. Belg. Bruss., tome XX, part. III, p. 206.

[f] Öfvers. Vet.-Akad. Förh. 1854, p. 173; Vet.-Akad. Handl., Bd. 7, No. 4, pl. 1 and 2.

[g] Overs. D. Vid. Selsk. Forh. 1863, p. 145; 1876, p. 174, tab. I—IV.

[h] Trans. Linn. Soc., vol. XXV (1866) p. 263, tab. 29—32; Proc. Roy. Phys. Soc. Edinb. 1864—1865, p. 215.

Schiödte[a], Reichert[b], and A. Agassiz[c] have laid the foundation of our present knowledge of the changes of development through which this peculiarity comes to pass.

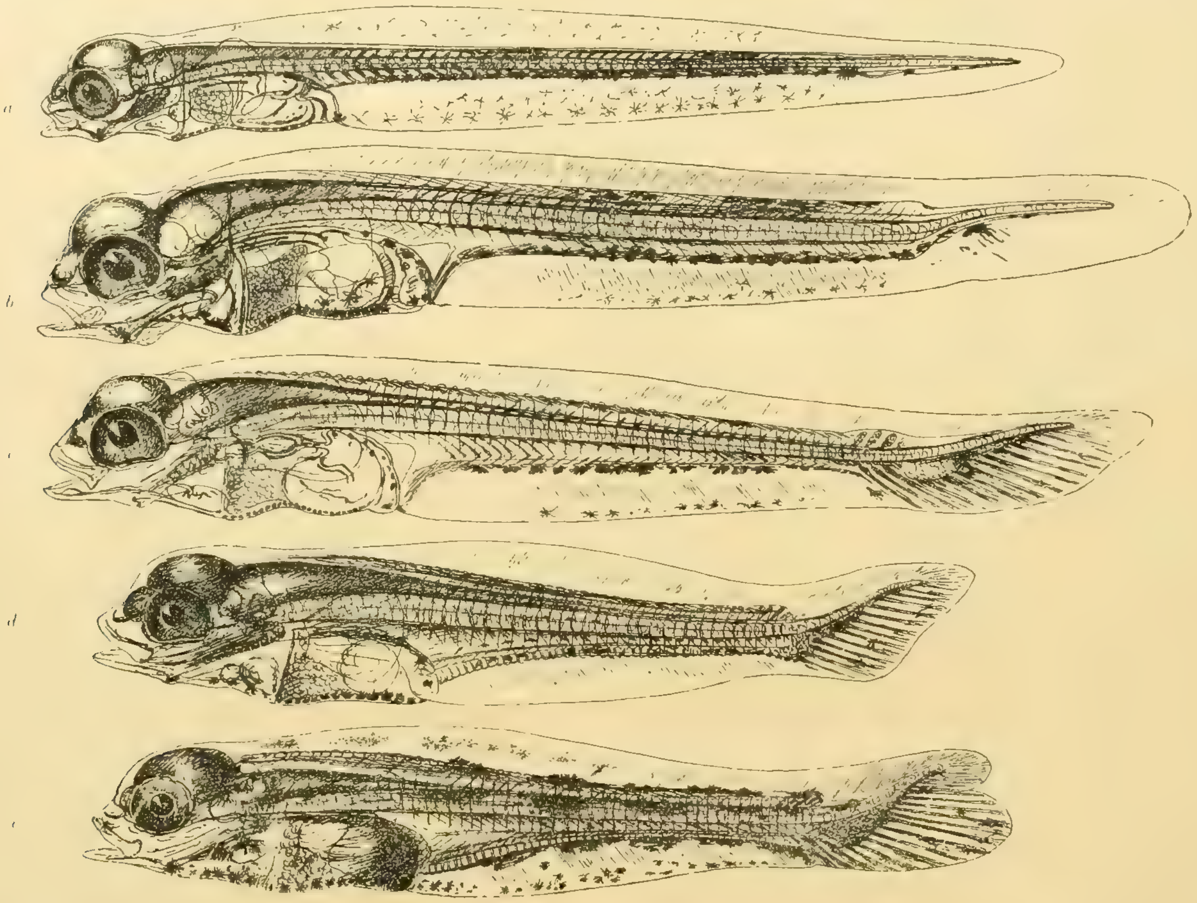

Fig. 98. Changes of growth in the larvæ of a *Pleuronectes americanus: a*, a larva about 4 mm. long, a day or two after the hatching of the egg, with fully symmetrical eyes. Pectoral fins well-developed. Larval vertical fin extending without a break from the occiput round the tip of the tail to the vent, the ventral part being somewhat broader than the dorsal. *b*, somewhat older and much less transparent than the preceding specimen. At the caudal end the notochord has begun to be elevated (the beginning of the heterocercal stage), and one or two very indistinct caudal rays have appeared in the vertical fin beneath it. *c*, a larva 5 mm. long, with a far greater number of rays in the distinctly heterocercal caudal fin, and with the segmentation of the spinal column more distinct. *d*, 7 mm. long, with indications of the separation of the caudal fin from both the dorsal and the ventral vertical fins, which are both still without rudiments of true rays. *e*, of the same length as the preceding specimen, with the primary tip of the tail forming a distinct lobe above the rudimentary caudal fin, and with rudiments of true rays in the future dorsal and anal fins. Larva still perfectly symmetrical. After A. Agassiz.

During the early development of the embryo in the egg and the first part of their independent existence the Flatfishes are fully symmetrical, like other vertebrates. Most, if not all, of the Flatfishes leave their eggs to develop freely floating in the sea — the eggs of the others lie loose on the bottom or are loosely attached to seaweeds or other objects — and during the first days of their existence the young are found swimming about, like the fry of other fishes, often at the surface, especially on calm and clear days. Within the island-belt of Bohuslän Malm found the young of the Brill swimming in this way in shallow water, in a bay off Strömstad; and under similar circumstances, near Känsö off Gothenburg, he found a young specimen, 12 mm. long, of the Sole, that had already undergone a great portion of its transformations. In the same way too, in the harbour of Copenhagen, Müller took with a hoop-net the young specimen of the Brill which is described by Schiödte; and the circumstances were the same when A. Agassiz found outside the harbour of Newport, quite near shore, the transparent young of the Bothoid form which he considered to belong to the same genus as the '*Plagusia*'[a] that Steenstrup had obtained from different parts of the Atlantic.

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[a] Naturh. Tidskr. Kbhvn, ser. 3, vol. V, p. 267, tab. XI.

[b] Arch. Anat., Phys. etc., Jahrg. 1874, p. 196; Stzber. Ges. Naturf. Fr. Berlin, 1874, p. 85.

[c] *Development of the Flounders*, Proc. Amer. Acad. Arts and. Sc., vol. XIV, 1878, plates III X.

The most remarkable point in the appearance of the larvæ of the Flatfishes for the first few days after they have left the egg, is the elongated, almost Eel-like shape of the body in the majority of the species (fig. 98)[b]. In the true Flatfishes this shape, which is deepened only by the continuous vertical fin, without true rays, which extends from the occiput round the tip of the tail to the vent, may be retained until the tail has assumed its heterocercal form and developed true fin rays. The pectoral fins have now appeared. Then the

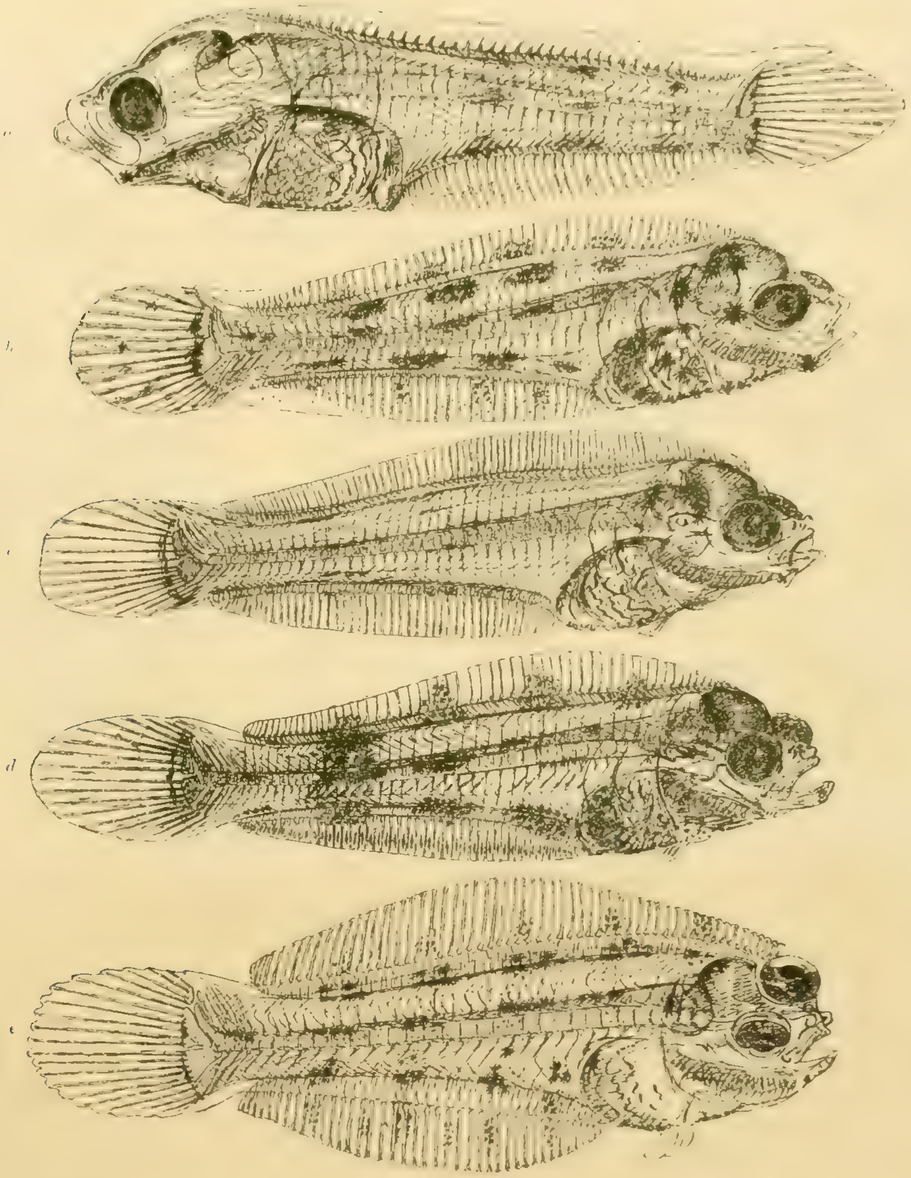

Fig. 99. Continuation of the changes of growth in the fry of *Pleuronectes americanus*. The body of the larvæ now grows deeper, though chiefly owing to the more and more distinct separation of the dorsal and ventral fins from the caudal fin. *a*, a larva 8 mm. long, with the left eye moved slightly forward, which appears from its altered position, first with relation to the brain, and second with relation to the hind (lower) end of the upper jaw-bone. Rudiments of the hypural bones now present under the raised posterior tip of the notochord. *b*, a rather more advanced larva, with the left eye visible from the right side of the body, raised slightly above the nasal profile, and moved forward to a point about $^1/_2$ its own length in front of the right eye. Caudal fin rounded, and rudiments of the ventral fins visible. *c*, a larva 12 mm. long, with more distinct ventral fins and with the left eye moved still farther forward. *d*, with the greater part of the left eye visible from the right side. *e*, a young specimen nearly 18 mm. long, with the left eye at the dorsal margin of the head, but almost entirely transferred to the right side, where it has also moved slightly back, while the front part of the dorsal fin has begun to develop to the left of it. After A. Agassiz.

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[a] That these small Flatfishes belong to the group of the Sole, is hardly probable. They are most like those larvæ which Raffaele (Mith. Zool. Stat. Neapel, Bd. VIII, p. 51, pl. 3, figs. 16 and 18) referred to the genus *Arnoglossus*. A true, transparent genus of Sole, on the other hand, or a larva thereof seems to be described by Brown-Goode (Proc. U. S. Nat. Mus. 1880, p. 344) under the name of *Thyris pellucidus*, from the deep water off Newport.

[b] Sometimes the larvæ are furnished with a long occipital fin-ray even in this stage: see Raffaele, l. c., pl. 3, fig. 12, and perhaps Emery, the same magazine, Vol. VI, pl. 10, fig. 26.

dorsal and anal fins begin to develop true rays; and finally the knob-like rudiments of the ventral fins appear. Up to now the head has been perfectly symmetrical. The eyes are perfect, with strong motory muscles, and have already begun to show that marked mobility which characterizes the Flatfishes in general, one eye lying on each side of the tumid middle brain. The covering bones of the brain-case are as yet mere membranous rudiments.

As the vertical fins now develop more and more, the caudal fin assumes its homocercal shape, the dorsal and anal fins are furnished with true rays and interspinal bones, and the body grows deeper. The young Flatfish now begins to lie oftener on one side, and swims in a more and more oblique position. One of the eyes begins to turn inwards, first moving somewhat forward towards the snout and inward towards the opposite side of the body (fig. 99, *b*, *c* and *d*), then up the forehead and over to the opposite side (fig. 99, *e*), and finally, in most cases, further and further back on this side, which is now the *eye side*, while the other side of the body has become the *blind side*. Sometimes, e. g. in the genus *Platophrys* (*Rhomboidichthys*), the eye retires so far back that it apparently lies high up on the occiput.

Meanwhile the covering bones of the skull have begun to develop, but they are still cartilaginous and thin, and of far too soft texture to hinder the movements and the changes in the position of the eye, which, on the other hand, both fix the eventual shape of these bones and leave room for their abnormal, secondary development. In the first place the front part of the frontal bones (fig. 100, *f* and *f'*) is compressed between the eyes (*o* and *o'*), while the posterior part of these bones (fig. 101, *fr. d* and *fr. s*, beneath in the figure) generally retain their breadth, but grow more and more distorted. The lateral ethmoid bones (the anterior frontal bones, fig. 100, *a* and *a'*; fig. 101, *fr. a. d* and *fr. a. s*), which are pierced by the olfactory nerves, are also removed and changed in development: the lateral ethmoid bones of the blind side (*fr. a. s*) and the true ethmoid bone (fig. 100, *e*; in fig. 101 not specially marked, but lying between *fr. a. s* and *fr. a. d*) form the usually raised, anterior and antero-exterior wall of the orbit, which is entirely closed on the outer (upper) side, this being due to the fact that the frontal bones of the blind side (*fr. s*) outside (above) the eye grow out anteriorly into a process which meets a corresponding excrescence in a backward direction of the lateral ethmoid bones of the blind side. Sometimes, however, these processes distinctly represent the suborbital bones[a]. They thus form an osseous bridge at the eventual dorsal edge of the head; and forward above this bridge, in most cases, grows the anterior part of the dorsal fin with its interspinal bones, which are supported thereon, just as the lateral muscles of the body (the occipital muscular part) extend forward to this point. The occipital ridge of the skull is also continued in most cases on this osseous bridge, which thus, although secondary, and issuing from the original lateral parts of the skeleton, acquires the appearance of a median formation. It is true that the passage of the eye exercises some influence over the position and form of the other bones of the skull: the parasphenoid bone anteriorly, from the orbital region, becomes more or less twisted, or more developed on the one side of the body (the blind side), and in most cases the vomer also shares this rotation. But the bones of the true cranium (except the frontal bones) undergo only slight

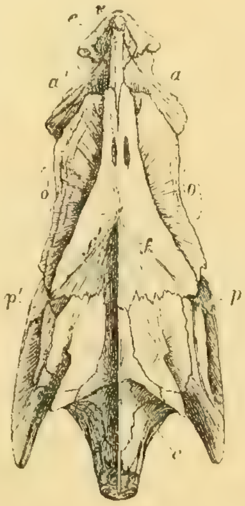

Fig. 100. Skull of a Cod, seen from above and reduced in size. After STEENSTRUP. *v*, vomer; *e*, ethmoid bone; *a* right, *a'* left lateral ethmoid bone; *o*, situation of the right, *o'* of the left eye; *f*, right, *f'* left frontal bone; *p*, posterior frontal bone on the right, *p'* on the left; *c*, upper occipital bone.

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[a] In *Pleuronectes cynoglossus* the osseous bridge thus formed is furnished, on the blind side, with a coarse-meshed network of bony ridges, belonging to a muciferous duct; and in *Solea* (*Achirus*) *lineata* the bridge is double. The only other trace of a true suborbital ring that occurs, is the frequent presence of a preorbital bone united to the lateral ethmoid bone of the eye side.

alteration or none at all, and the parts of the brain retain their original position in the skull, while in most cases the palatine teeth, and sometimes the jaw-teeth as well, remain almost unchanged.

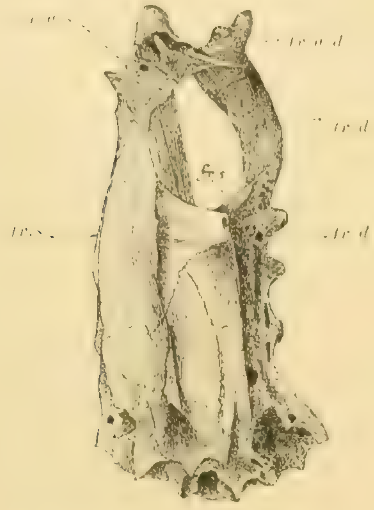

Fig. 101. Skull of *Pleuronectes platessa*, 1½ times the natural size. *v*, vomer; *fr. a. d*, right, *fr. a. s*, left lateral ethmoid bone; *fr. d*, right, *fr. s*, left frontal bone, the anterior parts of these bones being pressed forward to the right, and marked in the same way.

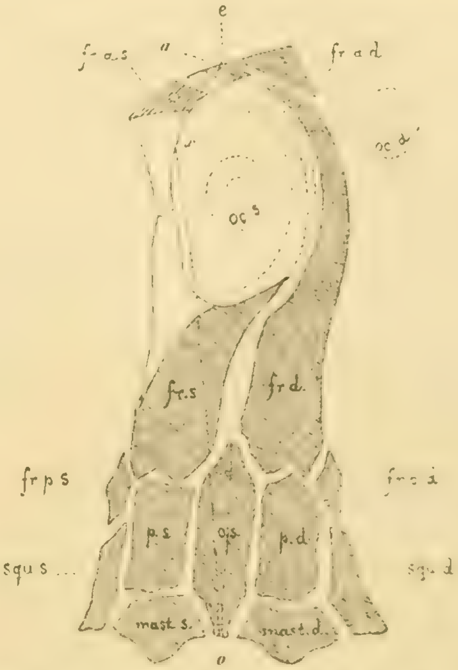

Fig. 102. Schematic figure of the skull of *Pleuronectes platessa*, borrowed from Traquair, as an explanation of the position of the various bones in the preceding figure. *e*, ethmoid bone; *fr. a. d*, right, *fr. a. s*, left lateral ethmoid bone, each pierced with a hole to receive the olfactory nerve; *fr. d*, right, *fr. s*, left frontal bone. — The unshaded parts of these bones on the left indicate their secondary excrescences. — *fr. p. d*, hind frontal bone on the right, *fr. p. s*, on the left; *p. d*, right, *p. s*, left parietal bone; *o. s*, upper occipital bone; *mast. d*, right, *mast. s*, left mastoid bone; *squ. d*, right, *squ. s*, left squamosal bone. The line *oa* shows the original dorsal edge of the skull, *ox* the secondary one. *oc. d*, right, *oc. s*, left eye.

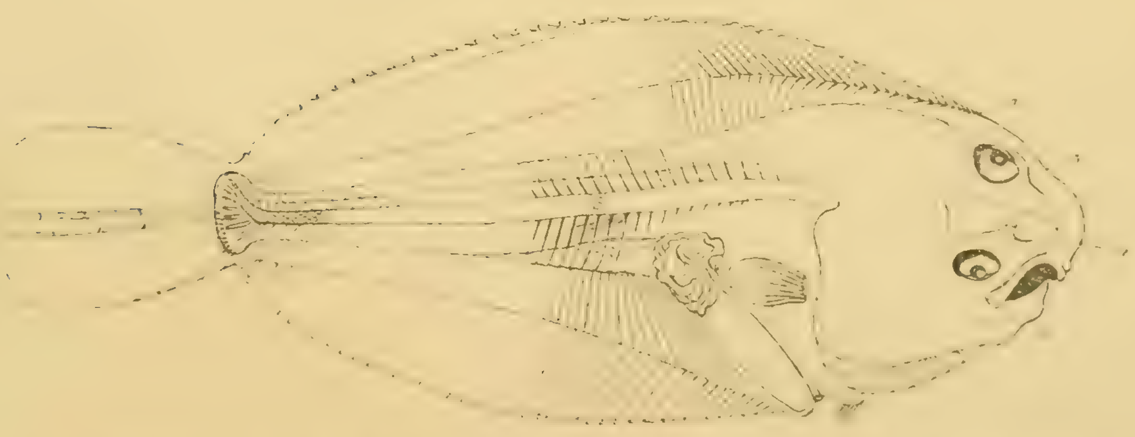

Fig. 103. Young Sole (*Solea vulgaris*). 12 mm. long and 4½ mm. deep. After Malm. *x—y*, that part of the future base of the dorsal fin under which the left (upper) eye has probably passed; *z*, the optic lobes of the brain.

These are the ordinary changes during the passage of the one eye from one side of the body to the other; but there are certain forms of Flattish (among them probably the common Sole, fig. 103) in which the dorsal fin, or at all events its predecessor, the embryonic vertical fin, extends so far forward on the dorsal edge of the head that the eye must force its way under the base of this fin, apparently straight through the head.

This is the course of the wanderings of the eye in the transparent, perfectly clear Flatfishes — probably immature forms of species not yet fixed — which Steenstrup and A. Agassiz (see above) have figured and described. The former assumed that the eye in its wanderings penetrates a part of the still membranous frontal bones of the blind side, while the latter in his figures shows the passage of the eye just under the lower ends of the interspinal bones of the dorsal fin.

These radical alterations are accompanied by a considerable difference in the shape of the body within the various genera of this series; but the intermediate forms prevent us from sharply limiting the groups we should like to define, and most writers agree in referring all these forms to one common family.

Fam. **PLEURONECTIDÆ.**

Body in adult specimens deep and strongly compressed, with the eye side, in the natural position, turned upwards and the blind side downwards. Dorsal and anal fins long, occupying at least the greater part of the length of the fish. Branchiostegal rays 6—8. Pseudobranchiæ present or wanting. Air-bladder generally wanting. Pyloric appendages few or wanting.

This family, which was established by Cuvier[a] under the name of *Poissons plats*, Rondelet's[b] *Pisces plani, spinosi*, bore the name of *ψηττοειδεῖς* in as early a writer as Aristotle; but its present systematic name, *Pleuronectidæ*, is no older than in Bonaparte's[c] time.

The shape of the body is no deeper here than in many other fishes, in certain Chætodonts and *Carangidæ* for example; and in the Rays flatness of body is conjoined with the same habits and in great part the same coloration and manner of locomotion as those of the Flatfishes. The asymmetry of the latter, however, as we have remarked above, is always enough to distinguish them. Whether this characteristic is immediately connected, as some have assumed, with the general absence of the air-bladder in the Flatfishes, is a very doubtful point, for both in *Paralichthys* (*Pseudorhombus*) *dentatus* (*melanogaster*) and in *Bothus* (*Rhombus*) *maculatus* Agassiz[d] found the air-bladder "well-developed" in the fry even before the eye had begun its wanderings. Again, the air-bladder is not wanting in all the rest of the members of this family. Costa[e] found it present in several Mediterranean species, even when full-grown, its size being greatest in *Rhomboidichthys podas;* it is hardly a functional organ, however, and during the course of development it shrinks or changes into a glandular organ, according to Costa, a lymphatic ganglion. The loss of the air-bladder, like the asymmetry, is thus a change of development. This is also true of the different colours of the two sides of the body. So long as the fry are symmetrical, the pigment is equally distributed on each side of the body; and even during the wanderings of the eye, the difference is slight. During this period dark transverse bands usually appear on the dorsal and anal fins and the neighbouring parts of the sides, as far inwards as to the end of the interspinal bones; and these transverse bands belong to the blind as well as to the eye side. During the advancing metamorphosis to asymmetry, however, the blind side loses more and more of its pigment, until at last, in most cases, it is bleached quite white, and the colour of the body collects on the eye side. In recent times, chiefly through the researches of the Frenchman Pouchet[f], science has been enabled positively to refer these changes of colour to the nervous system.

The lively description Heincke has given us of the changes of colour in *Gobius flavescens* (see above, p. 252) is a striking example of the power possessed by fishes in general of adapting their own colour to that of their surroundings; but the Flatfishes enjoy this faculty to a still higher degree, especially during youth.

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[a] *Regn. Anim.*, edit. I (1817), p. 218.

[b] *De Piscibus* (1554), p. 309. The Rays were *pisces plani, cartilaginei.*

[c] *Sagg.*, 1831; *Syst. Icht.* Isis 1833. Rafinesque called the family *Pleuronectia* (1815), and Risso used the French name *Pleuronectides* (1826).

[d] *Devel. Flound.*, l. c., p. 11, pl. VI and VII.

[e] *Fn. Regn. Nap.*, Malacott., Sottobr., Pleuron., p. 64.

[f] *On the connection of nerves and chromoblasts*, Monthl. Micr. Journ., Dec. 1871, p. 285; *Des changements de coloration sous l'influence des nerfs*, Journ. de l'Anat., Phys. 1876, pp. 1 and 113, pl. I—IV. Cf. Smitt: *Ur de högre djurens utvecklingshistoria*, p. 271.

Both Pouchet and Agassiz (l. c.) succeeded best in their experiments on specimens of *Bothus* which were shifted from vessels and bottoms of different colours and into different lights, always with the result that on a dark bottom and in dark environments the fish turns dark, while it assumes a lighter tint when the circumstances are reversed. In this manner it conceals itself in its free state, either to lie in ambush for some victim or to escape the notice of some foe. But Pouchet, whose subjects were Turbots of different sizes, varying in length between 6 and 25 cm., found that they lost this power of changing colour when he blinded them, and also forgot to cover themselves with sand when placed on a sandy bottom, an end which they otherwise attain quite skilfully by a few sharp strokes with the hind part of the body. It was thus evident that sight was a necessary adjunct of the changes of colour. The visual sensations pass from the eyes to the brain, where they are exchanged for nervous vibrations that start the expansion or contraction of the chromatophores; and these nervous vibrations, according to Pouchet, are conveyed partly along the Trifacial nerve (the fifth pair of nerves in the head), partly by the great sympathetic chain of ganglia, to the spinal nerves. The spinal cord itself, according to Pouchet's investigations, does not play the least part in the transmission of these vibrations; but the sympathetic nervous chain which lies beneath the vertebræ on each side, and is connected with the cranial nerves, especially with the Trifacial nerve, sends out branches to each pair of the spinal nerves. If these nerves are destroyed in that part of their course that contains elements of the sympathetic nervous system, they also lose the power of transmitting any influence to the chromatophores. This connexion between the action of the brain and that of the sympathetic nervous system on the chromatophores in the skin, may well serve as an explanation of the blending — in many cases quite incomprehensible — of voluntary and involuntary changes in the colour of the skin under the influence of phenomena of light or sensual impressions, a circumstance which may often be observed even in the higher animals. The development of the spawning-dress seems also to be due chiefly to the influence exercised by the sympathetic nervous system at the time for the higher development of the generative organs and their maturation.

Besides the iridocytes of Pouchet — pigmental bodies or cells containing powerfully refractive, microscopical disks arranged in parallel lines or heaped like the coins in a roll, to the presence of which bodies the gray colour of the skin of the Flounders is due — we here find chromatophores[1] of black, yellow and red. The black chromatophores, which are always more or less ramified when they expand, but may contract into a tiny dot, lie nearest the surface; and the position of the yellow and red varies considerably in the different species. The varying expansion or contraction of these cells, is adapted to the colours of the surroundings of the fish, and produces that arrangement of colours on the eye side of the Flounders which sometimes renders them so difficult to discover.

Thus, the nervous system and, in particular, the sense of sight are the determinant factors in the changes of colour; and Pouchet has also shown that habit exercises no small influence on this faculty. Out of a number of Turbots that were kept alive in a well, he selected the palest. He then put it in a vessel with a brown bottom, and five days elapsed before the fish could adapt its colour to that of the bottom. He now moved it to a light sandy bottom, and in two days the fish had regained its former light colour. Again he moved it to a brown bottom, and now only two hours produced the same effect as it had taken five days to gain before. "The faculty of changing colour," says Pouchet, "is thus influenced by habit, and this too, soon enough, for the Turbot in question had lived at most only three months on the light bottom where we found it. From an anatomical point of view it is very difficult to explain this *habit*. Perhaps the nerves that start the contraction or expansion of the chromatic cells, are in some way paralysed by want of exercise, and require some time to recover from this paralysis. Or have the chromatic cells lost too much of their contractile matter? Or must we look for the reason of their immobility outside them: perhaps in the surrounding tissues, the resistance of which prevents the expansion of the cells? All these are questions to which no answer can be given at present. But we can easily realise that the fact that habit thus gains influence *so quickly*, is of some zoological importance. As it can be shown that the faculty of changing colour may be restricted in so short a time, we must also acknowledge that under certain circumstances, e. g. if a species were never enabled to exercise it for several generations, it may entirely disappear. Furthermore, the same stock may eventually be found to have given rise to two distinct races, the one deeply and the other faintly coloured, according to the different bottom on which each of them has taken up its abode; and both of them, through want of practice, may have lost their ancestors' power of changing colour. In this manner we may explain the origin of several varieties recognised by zoology, as due merely to the influence of habit. It is even probable that from this point of view we may be compelled to revise many species that have been established merely on the strength of characters of this description.”

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[1] Pouchet, who proposes to reserve the name of chromatophores for the more developed chromatic cells — in the *Cephalopoda* for example — calls these more protoplasmatic cells chromoblasts.

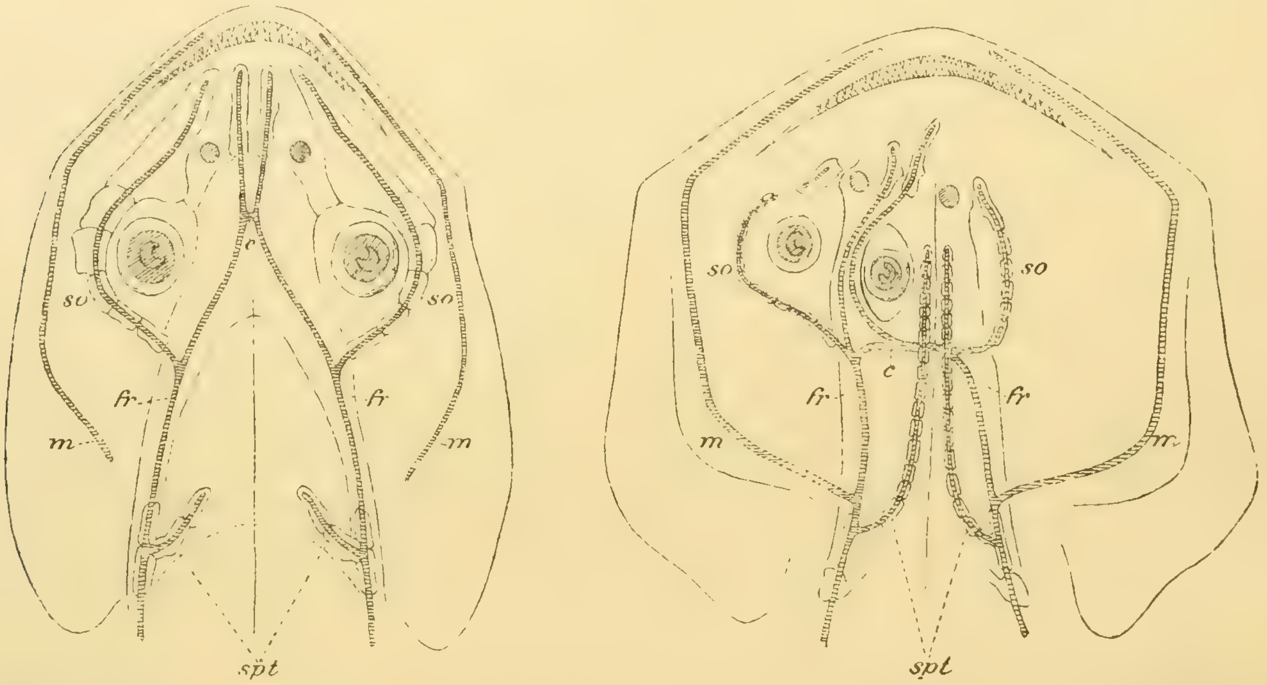

Fig. 104: Schematic figure of the cephalic system of the lateral line in a Cod; fig. 105: Similar figure of the head of a Turbot. After TRAQUAIR. *so*, suborbital branch; *m*, mandibular branch; *fr*, frontorostral branch; *c*, connecting branch between the two frontorostral branches: *spt*, supratemporal branch.

The sense of sight being now exclusively confined to one side of the body, the coloration of the body follows it, the other side of the body becoming albinistic. At the same time too, the great muscular mass of the body is developed more on the eye side than on the blind side. In most cases the paired fins are also reduced most and first on the blind side; but sometimes not only the beginning of the dorsal fin, but also the terminations of this fin and of the anal fin cross over to the blind side. The dental equipment of the jaws is also stronger, as a rule, on the jaw-bones of this side than on those of the eye side, and the jaw-bones themselves are generally larger on the blind side. Most often too, the muciferous ducts of the head are more developed on this side than on the eye side.

The scales of the body vary considerably in description, but are generally well-developed, so much so that in this respect, too, the Flatfishes take the same place among the Malacopterygian Physoclysts as the Scale-finned fishes (fam. *Squamipinnes*) among the Acanthopterygians. Sometimes the scales are middle-sized, but in that case often deciduous, sometimes small and firmly embedded in the skin. As a rule the scaly covering of the body advances over the base of the unpaired fins, either on the rays or on the membrane between them; and the head, too, is usually covered with scales right out on the snout. In this respect, too, the blind side is generally inferior to the eye side; and the scales are often wanting on the blind side of the head. Sometimes the scales are cycloid (smooth-margined), sometimes ctenoid (rough-margined), and sometimes a portion of them are changed into spinous tubercles. In those of the species with ctenoid scales with whose changes of development we are acquainted, the scales are cycloid over the whole of the body during youth; while in older specimens they are ctenoid on the entire eye side or some part thereof, but on the blind side may remain cycloid or be changed to ctenoid scales there as well.

Almost the same remarks apply to the system of the lateral line. As a rule it is well-developed, though sometimes externally indistinct. In all the Scandinavian species its extent is normal, though a portion of it on the head is sometimes reduced by the removal of the eye. Thus, in the Turbot all those branches of the system that appear in a Codfish for example, are repeated, as appears from a comparison between fig. 104 and fig. 105. From the temporal region on each side of the body an occipital (supratemporal, *spt*) branch runs up towards the dorsal edge. In the Flounders this branch runs to each side of the dorsal fin and coasts it in a forward direction to the beginning of the fin, or ramifies, in which case it may follow the base of the dorsal fin both forward and back (fig. 106). Down from the temporal region runs the mandibular branch (*m*), along the hind margin of the preoperculum and on the under surface of the lower jaw. In a forward direction the frontorostral branch (*fr*) crosses the frontal and ethmoid bones to the turbinate bones, with a connecting branch (*c*) between or behind the eyes, from the branch on one side of the body to that on the other. Each frontorostral branch sends out a suborbital branch (*so*) behind the eye. In the Plaice (figs. 106 and 107) the frontorostral branch of the blind side disappears behind the orbital region; but the connecting branch is persistent, being externally visible on the eye side, and at the hind margin of the upper (transferred) eye passes straight through the head to the remainder of the frontorostral branch of the blind side. In several exotic genera the lateral line of the body is doubled or even trebled, partly, as we have mentioned above, by a dorsal branch coasting the base of the dorsal fin, and partly by a ventral branch along the base of the anal fin. In these cases it may happen either that both sides of the body are alike in this respect, or that the eye side is furnished with two or three lateral lines and the blind side with one or none.

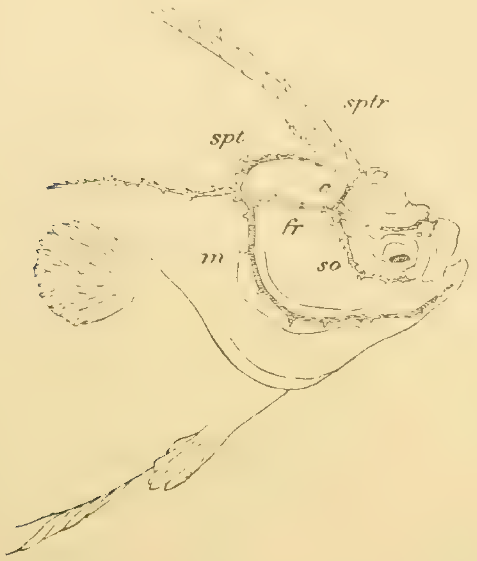

Fig. 106. Cephalic system of the lateral line on the eye side of a Plaice. After **Traquair.** *sptr*, dorsal branch of the lateral line. For the signification of the rest of the letters see the preceding figure.

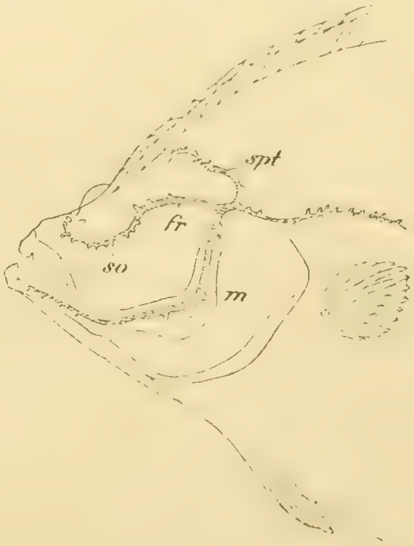

Fig. 107. Corresponding figure of the blind side of the head in the same fish. After **Traquair.** For the signification of the letters see the preceding figure.

All the fin-rays are soft (articulated), sometimes simple and sometimes branched. Sometimes they are simple in all the fins, sometimes branched in the caudal fin alone, sometimes in the paired fins as well, and sometimes branched in all the fins. The pectoral fins are usually set fairly high, and the ventral fins in front of, or sometimes exactly in, the perpendicular dropped from the insertion of the former fins. These paired fins, however, are very often reduced, as we have mentioned above; and the ventral fins may be sometimes united by the fin-membrane to the anal fin. In this case, when only one of the ventral fins (that of the eye side) is developed, it presents the external appearance of an anterior lobe of the anal fin.

At the beginning of the latter fin, just behind the vent, there sometimes projects a strong spine. This is the lower end of the first interhæmal spine of the anal fin, which spine is also called the postabdominal bone, and in the Flatfishes is extraordinarily well-developed and together with the hæmal spine of the first caudal vertebra, on the front of which it is supported at the top, forms the curved hind wall of the abdominal cavity, which is comparatively narrow in these fishes.

The abdominal cavity is at first comparatively long, the vent in the larvæ when just hatched, sometimes lying even behind the middle of the body. But during the course of development the vent is moved farther and farther forward, while the abdominal cavity is relatively shortened until in full-grown specimens it becomes more or less semicircular in its median longitudinal (sagittal) section. The vent thus assumes a very forward position, and in many forms lies at the middle of the ventral margin; but in the most distorted types it passes over to the blind side. The greater part of the left side of the abdominal cavity is occupied by the liver, around which, above and behind, lie the œsophagus and the stomach, which is only slightly divided from the latter, behind and below, the intestine. The intestine usually forms an immediate continuation of the stomach, being sharply divided from the latter internally by a very muscular, funnel-shaped pylorus, below which hang the pyloric appendages, which are few and, in most cases, small. To the right of the abdominal cavity lie the coils of the intestine, attached to the mesenterium, with its numerous and large, lymphatic vessels. Here too, we find the spleen and the gall-bladder, which is generally large. The kidneys are, as usual, situated in the abdominal cavity, just under the spinal column, and the ureters are united into a urinary bladder. The organs of generation lie at the middle of the hind wall of the abdominal cavity; but when they are much developed and tumid, the space allowed for them within the abdominal cavity is too small, and they force their way back, in a flat, conical shape, between the large muscles of the body and the interhæmal bones of the anal fin or the hæmal spines of the caudal vertebræ, on each side of the latter.

The family of the Flounders is one of those with the most numerous species. GÜNTHER in his *Catalogue* of 1862 gives the number of species in this family as 229, distributed among 34 genera; while in 1883 JORDAN and GILBERT recognised nearly 400 species[a]. In his *Introduction to the Study of Fishes* (pp. 553—559) GÜNTHER gives 42 genera.

The geographical range of the family embraces all the seas from the Equator to the Polar Regions; and some of the species even make their way into fresh water. The greatest abundance of forms belongs, it is true, to the tropical seas; but the largest species belong to temperate and cold climates. The family is represented even off Bear Island and Spitzbergen.

On account of the great variety of forms a subdivision of the family is quite necessary. At the time when the general signification of the genus corresponded to the family of modern ichthyologists, a division of this nature was proposed by QUENSEL[b], who broke up the old genus *Pleuronectes* into two genera: *Pleuronectes,* "with the mouth at the tip of the head and furnished with distinct, movable jaws, the lower being longer or more prominent than the upper," and *Solea,* in which "the mouth is crescent-shaped, set obliquely at the sharp edge of the under margin of the head, and furnished with indistinct jaws, the upper being prominent and longer than the lower." According to the same character in all essential respects BONAPARTE[c] distinguished between the subfamilies *Pleuronectini*, "*in cui la mascella più lunga è l'inferiore*," and *Soleini*, "*in cui la più lunga è la superiore*". GÜNTHER[d] also divided the family of the Flounders into two groups: I, with the jaws and their teeth almost equally developed on each side of the body, and II, with narrow mouth, in which the teeth are more developed on the blind side than on the eye side. Thus we already have a suggested principle on which to arrange this family in three subfamilies. Furthermore, GILL soon afterwards[e] quoted CUVIER's distinction between the subgenera *Hippoglossus* and *Rhombus*, and on the strength of the structure and position of the ventral fins in the latter genus established the subfamily *Rhombinæ*. Thus we now have fixed characters for four subfamilies:

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[a] The number of the species cannot be fixed exactly.

[b] Vet.-Akad. Handl. 1806, pp. 44 and 203.

[c] *Icon. Fn. Ital.*, tom. III *Pleuronectes macrolepidotus*, num. p. 22. Cf. also BLEEKER. *Atl. Ichthyol. Ind. Néerl.*, tom. VI, pp. 4 and 16.

[d] *Brit. Mus. Cat. Fish.*, vol. IV, p. 400.

[e] Proc. Acad. Nat. Sc. Phil. 1864, p. 215.

1. *Heterosomata soleina*, with the upper jaw most prominent;
2. „ *pleuronectina*, with the lower jaw most prominent, the gape small and oblique, and the jaw-teeth considerably reduced on the eye side;
3. „ *hippoglossina*, with the lower jaw most prominent, the gape middle-sized or large, the jaw-teeth developed almost as much on the eye side as on the blind side, the ventral fins one on each side of the ventral margin, and the rays of these fins close together at the base.
4. *Heterosomata bothina*, with the lower jaw most prominent, the gape middle-sized or large, the jaw-teeth almost equally developed on both sides of the body, the ventral fin of the eye side inserted just at the ventral ridge, and the rays of the ventral fins more or less far apart at the base[a].

SUBFAMILY SOLEINA.

Ethmoid (rostral) cartilage of the snout well-developed, forming the framework of a more or less high, but compressed elongation of the head in a forward direction. This elongated part of the head generally curves downwards, in a more or less hooked shape, in front of or even under and behind the mouth, which is narrow and bent. Jaws (at least the maxillary bones) more or less completely hidden by the lips, and the jaw-teeth developed only on the blind side, where the vent has also taken its position. Eyes small or hidden. Pseudobranchiæ wanting; gill-rakers also wanting, or only few and tubercular.

The most conspicuous of the characters given above, the projection of the snout in front of the mouth, is valid in most cases and, in particular, in the Scandinavian fauna. But the connexion between the forms of the family impairs the universal validity of this character, for there are Soles — e. g. *Brachirus zebra* of the Pacific Ocean and the coast of India — in which the mouth lies almost exactly at the middle of the tip of the head, with the snout projecting extremely little, if at all, beyond the tip of the lower jaw. In such cases, however, the members of this subfamily may be easily recognised by their small eyes and the absence of teeth on the jaw-bones of the eye side.

Just as we have ranged the Flounder-fishes before the Codfishes, on account of their far more advanced metamorphosis of the Anacanthine type[b], we also give the Soles the first place in the Flounder family, because the asymmetry has evidently advanced farthest in their case. It is also within this subfamily that most of the reductions most frequently occur, the pectoral and ventral fins of one side or of both disappearing, or the eyes being hidden by the skin. On the other hand, as we have mentioned above, the number of the lateral lines is very often increased in these fishes, and numerous feelers (barbels) are in many cases developed on the head, especially on the blind side. The peculiarity so characteristic of the family of the Flounder-fishes that lies in the great length of the dorsal and anal fins (their extension over the greater part of the edges of the body), also reaches the highest point of its development in the Soles. The dorsal fin may not only commence far out on the snout, but may even extend downwards round the tip of the snout along its ventral margin, which in these cases is elongated into a hooked, recurved projection of the upper jaw. This projection sometimes entirely surrounds the lower jaw[c].

This subfamily contains perhaps half the species included in the whole family. In the subfamily too, the most numerous and most singular forms belong to the tropical seas; but the most delicious and most valuable is a member of the Scandinavian fauna.

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[a] In this last respect the Mediterranean *Citharus linguatula* is an exception, having the ventral fin of the eye side inserted just at the ventral ridge. But the ventral rays are close together at the base.

[b] The name of *Anacanthini* was unfortunately applied to an order including the Codfishes and Flounders by MÜLLER (Berl. Abh. 1844), BONAPARTE having already employed it in 1837 (*Syn. Vert. Syst.*) for a subfamily of the Rays.

[c] As we have not been able to find a trace of pseudobranchiæ in *Solea* or in *Cynoglossus*, the two extremes of the variations of form in the subfamily, we have assumed that this character holds good for the whole subfamily. KROYER, too (*Danm. Fiske*, Bd. 2, p. 476), has remarked that *Solea vulgaris* is without pseudobranchiæ.

GENUS SOLEA.

Body elliptical and, with the exception of the blind side of the snout, entirely covered with small ctenoid scales, continued over the vertical fins, which are separate from each other. Anal fin without the anal spine. Commencement of the dorsal fin on the snout. Eyes, as a rule, on the right side of the body, the upper (transferred) eye being situated farther forward than the lower. Tip of the snout round and curving only slightly over the tip of the lower jaw (forming no recurved hook). No vomerine or palatine teeth. Lateral line on each side of the body simple and usually straight.

With this limitation — based on GÜNTHER's opinion — the genus *Solea* comprises about 40 species from the tropical and the north temperate seas, and shows considerable variety of form. The form varies from oblong (tongue-shaped) to broad elliptical, with perfect and well-developed pectoral fins on both sides or with these fins reduced — either on the blind side or on both — and with the ventral fins both entirely free from the anal fin or with the ventral fin of the eye side united by a membrane to the first ray of that fin. It has, therefore, been proposed to divide the genus into several subgenera, which still pass into each other through intermediate forms. One of these proposed subgenera, in which the Sole, the type of the genus, is included, is characterized by the oblong body, the depth of which measures at most $^2/_5$ of the length to the base of the caudal fin, the well-developed pectoral and ventral fins, of almost equal size on both sides of the body and with the rays covered for at least half their length by the scales, the entire freedom of the ventral fins from the anal fin, and the straightness of the lateral line behind the head. This subgenus would contain only a few species from the east of the Atlantic and the Mediterranean.

THE SOLE (SW. TUNGAN).

SOLEA VULGARIS.

Plate XX, fig. 2.

Depth of the body greatest in the females, least in the males and young specimens, and varying between about 30[a] *and 35 % of the length thereof. Length of the head greatest in the females, and varying between about 16 and 19 % of that of the body. Length of the pectoral fins greatest in the males, only slightly less on the blind side than on the eye side, and varying between about 33 and 40 % of that of the head. Length of the ventral fins in proportion to that of the body about the same in the males and females, and varying between about 26 and 28 % of that of the head. Nostrils of the eye side set close beside each other and near the margin of the upper lip, the anterior tubular and the posterior sunk in close to the lower eye. Nostrils of the blind side far apart, the anterior tumid and conical — without wide opening or fimbriæ at the opening — and set at about an equal distance from the tip of the snout, the corner of the mouth or the posterior nostril, which is somewhat farther from the corner of the mouth and just behind the perpendicular therefrom.*

R. br. 7(6—8); *D.* 70—84[b]; *A.* 54—67[c]; *P.* 1 + 6 l. 7 l. 8; *V.* 5[d]; *C.* x + 14 + x; *Lin. lat.* ca 140[e]; *Vert.* 10 + 39.

Syn. *Βούγλωσσος*, ATHEN., *Buglossus*, RONDEL.; *Solea*, OVID., PLIN., cett. vide ART. et BONAP.

Pleuronectes oblongus, maxilla superiore longiore, squamis utrinque asperis, ART., *Gen.*, p. 18; *Syn.*, p. 32; *Spec.*, p. 60; LIN., *Fn. Suec.*, ed. I, p. 112, No. 299; *It. Wgot.*, p. 178.

Pleuronectes Solea, LIN., *Syst. Nat.*, ed. X, tom. I, p. 270; NILSS., *Prodr. Ichth. Scand.*, p. 60; SCHAGERSTR., Physiogr.

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[a] According to LILLJEBORG, sometimes (in young specimens from the Mediterranean) 26 %.

[b] Sometimes 87, according to GOTTSCHE, or 97, according to DAY.

[c] Sometimes 73, according to LILLJ., or 83, according to DAY.

[d] 4—6, according to KROYER.

[e] 110—142, according to STEINDACHNER; 160, according to GÜNTHER. KRØYER counted about 130.

Sallsk. Tidskr., I, p. 312; Ekstr., *Skand. Fisk.*, ed. 1, p. 165, Wright, tab. 39.

Solea vulgaris, Qvens., Vet.-Akad. Handl., 1806, p. 230; Holtb., *Beskr. Boh. Fisk.*, part. III (Gbgs. Vett. Vitt. Samh. N. Handl., V, 1822), p. 59 c. fig.; Gottsch., Arch. Naturg., 1835, p. 182; Bonap., *Icon. Fn. Ital.*, tom. III, *Pesci*, I, num. p. leg. 101; Yarr., *Hist. Brit. Fish.*, ed. 2, vol. II, p. 347; Kr., *Danm. Fiske*, vol. II, p. 467; Nilss., *Skand. Fn.*, *Fisk.*, p. 651; Gthr, *Cat. Brit. Mus.*, *Fish.*, vol. IV, p. 463; Steind., Stzber. Akad Wiss. Wien, Math. Naturw. Cl., Bd. LVII, i, 1868, p. 720; Coll., Vid. Selsk. Forh. Christ., 1874, Tillægsh., p. 148; ibid. 1879, No. 1, p. 83; Winth., Naturh. Tidskr. Kbhvn, ser. 3, vol. XII (1879), p. 41; Buckland, *Nat. Hist. Brit. Fish.*, p. 184; Mor., *Hist. Nat. Poiss. Fr.*, tom. III, p. 304; Day, *Fish. Gt. Brit.*, *Irel.*, vol. II, p. 39, tab. CVI; Möb., Hcke, *Fisch. Osts.*, p. 100; Lill., *Sv. Norg. Fisk.*, vol. II, p. 416.

Solea Linnei, Malm, *Gbgs. Boh. Fn.*, p. 532.

The ordinary length of the Sole on the west coast of Sweden is from 30 to 35 cm. The largest specimen Ekström saw, was 52 cm. long. Further south the species attains a greater size. Yarrell mentions a specimen from the English coast off Totness that was 26 in. long and weighed 9 lbs. The largest Soles Buckland could procure for his museum, were two from Ireland, which together weighed nearly $5^1/_2$ kgm. The body is of an elongated oval form, deepest in front, and thin. The greatest depth, which occurs at the end of the first third of the length of the body, measures between the bases of the dorsal and anal fins, about $^1/_3$ of the length from the tip of the snout to the end of the caudal fin, and when the breadth is taken between the margins of the dorsal and anal fins when expanded, $^1/_2$ the length to the base of the caudal fin. The least depth, just in front of the base of the caudal fin, is about $^1/_{13}$ of the length of the body to the end of the caudal fin. The greatest thickness is $^1/_{13}$ of the length of the body to the base of the caudal fin or $^1/_6$ of the greatest depth between the fins. The curves of the dorsal and ventral margins are similar. The head is blunt, with rounded, soft and fleshy snout, which curves downwards towards the gape, resembling a parrot's beak, but surrounds only the tip of the lower jaw. The mouth is small, the cleft of the mouth curved in a crescent shape, but larger, more curved and with more fleshy lips on the blind side than on the eye side. On the eye side, however, the under lip forms a dermal fold, which covers the margin of the upper jaw when the mouth is closed; on the blind side the margins of both jaws are surrounded by a round swelling. On the eye side of the mouth there are no teeth: but on the blind side both jaws are furnished with very fine, setiform, movable teeth, which are set in several irregular rows, so densely that they form broad patches. This structure is not fully apparent, however, until the mouth is dissected. Then we find that the jaw-bones of the eye side are considerably reduced. In front of the tip of the vomer — the head of which is furnished posteriorly on each side with an articular surface for the palatine bones — lies the articular knob of the maxillary bone. This upper (proximal) part of the maxillary bone sends out a process which covers the outside of the upright nasal process of the intermaxillary bone, while the maxillary bone proper projects downwards in the form of a somewhat curved osseous body, triangular above and terete below (distally), and forming the framework of the upper jaw. The intermaxillary bone of this side, on the other hand, is so reduced that it consists almost exclusively of the triangular, articular part. The latter, however, sends out an upright nasal process, in the arch formed by the downward curve of the front end of the ethmoid bone, and is so developed and curved towards the blind side that there it meets and articulates with the intermaxillary bone of that side, thus forming the true middle part of the margin of the mouth. On its own side, however, this intermaxillary bone is merely a pointed splinter, lying along the anterior side of the maxillary bone, and occupying about half the length of the latter. On the blind side the intermaxillary bone is the most powerful bone in the upper jaw, and is shaped like a sharply curved scythe, the handle of which consists of the articular part of the bone. This part sends out its nasal process obliquely forward, in the direction of the eye side and in front of the upright nasal process of the latter, in the shape of a pointed spine. In front, on the 'handle', this intermaxillary bone is also quite toothless; but the under (inner) surface of the bent part of this bone is very densely covered with teeth, which strongly remind us of the dentition of the *Chætodontidæ*. The maxillary bone of the blind side essentially resembles that of the eye side, but is more robust, longer, and curved, and for the greater part of its length behind the articular part is entirely hidden by the intermaxillary bone. The structure of the lower jaw is no less singular. Its two halves are considerably different from each other: the half on the eye side is not very unlike the branch of the lower jaw in the generality of fishes, especially in the Plaice, for example: but it is entirely toothless. The branch of the blind side is only slightly changed in the articular (posterior) part, but the anterior or dental part is much shortened, deeper than long, of an irregular quadrilateral shape, toothless in front, and behind, in the toothed part, curved outwards — somewhat as in *Mugil* — and still farther back raised into a process which meets, and is united by strong ligaments to, the hind part of the intermaxillary bone. The branch of the lower jaw on the blind side is thus much deeper, but shorter than that on the eye side, its depth being about $^1/_2$ the least depth of the tail or twice the longitudinal diameter of the eye. There are on each side three round, upper pharyngeals — the middle one being considerably larger than the other two — and one oblong, lower pharyngeal. All of them are set with movable, cardiform teeth, like the jaw-teeth. The gill-openings are small; the opening on the blind side extends up to the top of the insertion of the pectoral fin, but on the eye side only to the lower end of this insertion. The opercula have rounded, smooth margins and are entirely covered with a thick, scaly skin, but under their rims protrudes the margin of the smooth, scaleless branchiostegal membrane. The two branchiostegal membranes are united underneath, and surround the anterior lower point of the clavicular bones, at the point where the latter are united to each other and to the lower posterior prong of the urohyoid (basi-branchiostegal) bone. The latter bone is shaped, as in most of the Flatfishes, like a joiner's square, the end of the anterior (longer) prong being attached to the under surface of the hyoid bone, and the posterior prong pointing in a downward direction and united by a ligament to the top of the lower junction of the clavicular bones. Thus, the two clavicular bones and the urohyoid bone are united in front into a point, which is generally covered underneath by the coalescent branchiostegal membranes. There are usually 6 or 7[a] branchiostegal rays on each side, sharply bent, and covered by the opercula. The outer (distal) part of the first branchiostegal ray on one side is coalescent with the corresponding part of the same ray on the other side. The eyes are oblong, and less prominent than in the rest of the Scandinavian Flatfishes. The upper eye lies half its own length in front of the lower, which is situated above and close to the corner of the mouth. The distance between the eyes is about equal to the longitudinal diameter of the iris. The pupil is round, without any intruding excrescence from the iris. The skin of the body may be drawn over the eye in the form of an eyelid. The nostrils are more or less perfectly tubular. The nostrils of the eye side are set close to each other and near the anterior margin of the lower eye, close to the mouth, the anterior being perfectly tubular, the posterior larger, with the tube slit behind. The nostrils of the blind side, on the other hand, are far apart, the posterior being situated fairly high above the corner of the mouth and the anterior about half-way between the posterior and the tip of the snout.

The surface of the body is even, and covered on both sides with imbricate, oblong scales, rounded at the corners and distinctly ciliated behind. The scales cover the surface of the eye side of the head entirely, but only two-thirds of the surface of the blind side, the anterior third of this side of the head (the mouth and snout), as well as a part of the base of the dorsal fin and the margins of the operculum of this side, being thickly strewn with soft tubercles or warts, with a crest of short, hairlike cirri at the tip. The fin-rays are also covered with scales, at least for some distance from the base. The rays of the vertical fins are each furnished with several rows of more or less pointed scales, and on the eye side this covering extends almost out to the tips of the rays. The paired fins are covered with scales only on the outer surface of the rays and for about half their length. On the blind side too, the covering of scales does not extend so far out on all the fins, and the ventral fin of this side (sometimes the pectoral as well) is generally scaleless. Behind the head the lateral line is distinct and perfectly straight, or slightly curved in the abdominal region, where it also lies nearer the dorsal than the ventral margin. But the cephalic system of the lateral line is indistinct, with the exception of the dorsal branch, which curves upwards and forwards in an arch on the occiput. The vent lies very far forward, between the ventral fins and just in front of the beginning of the anal fin, entirely on the blind side, but close to the ventral margin. Just behind the vent lies the genital opening, and between them we find a dermal flap, which is sometimes erected in the shape of an acute-angled triangle.

The dorsal fin is fairly low, somewhat higher in the males than in the females, its longest rays measuring about 20—23 % of the greatest depth of the body, 91—92 % of the least depth of the body or 40—45 %

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[a] GOTTSCHE has sometimes found 8 branchiostegal rays.

of the length of the head. The fin begins in front of the upper eye, almost at the tip of the snout, and extends to the base of the caudal fin. It usually contains from 72 to 84 rays, all branched and recurved, with the tips lying within or only just outside the fin-membrane and curved towards the blind side. The anal fin is of the same shape as the dorsal, begins below and somewhat in front of the insertion of the pectoral fins, ends below the termination of the dorsal fin, and usually contains from 60 to 67 rays, which resemble those of the dorsal fin. The pectoral fins are oval, narrow and small, the length of the base being about ${}^1/_4$—${}^1/_3$ of that of the fin. They contain from 7 to 9 rays, the uppermost ray being simple, the others branched. The ventral fins are still smaller, and usually contain 5 rays, all of which are branched, the first and last very indistinctly, and close to each other at the base. The rounded caudal fin, the length of which measures about ${}^1/_{10}$—${}^1/_9$ of that of the body, is made up of 14 branched rays and two or three simple, supporting rays on each side.

The colour of the eye side is brown, marbled with dark grayish brown. The fins are somewhat lighter, but the outer half of the pectoral fin on this side is dark, almost black. The scales are black at the margin, apparently dividing the body into squares. The blind side is white, seldom spotted with brown, but almost always with a large brown spot near the caudal fin. The white colour reddens, however, after the death of the fish. Iris dark, brassy yellow. Pupil green, but tinged with blue after death. On the strength of information given him by the fishermen of Bohuslän, HOLLBERG distinguished between two colour-varieties, the brown Rock Sole (*bergtungan*) and the greenish Sand Sole (*sandtungan*); but EKSTRÖM pointed out[a] that the difference in colour probably arises from the nature of the sea-bottom. *Reversed* Soles, with the eyes on the left side, are of frequent occurrence on the English coast according to YARRELL and DAY; and the latter writer makes the same statement with regard to *double* Soles, which are coloured on both sides of the body.

The abdominal cavity proper is extremely short in the Sole, its length being about ${}^1/_2$ that of the head or about 9 % of that of the body. On each side of the hæmal and interhæmal spines of the anal fin, however, the abdominal cavity is secondarily elongated, partly, as in most of the Flatfishes, to receive the long organs of generation, and partly to make room for the intestine and the kidneys. In two females we find the posterior ends of the ovaries situated at about the beginning of the last third of the length of the body. The testes of the males examined at the same time of year, in January, occupy the anterior part of the secondary abdominal cavities, and have the appearance of round, flattened glands, of a longitudinal diameter about equal to the length of the ventral fins. The liver occupies the entire left side of the abdominal cavity proper, and at the top surrounds the œsophagus and its immediate continuation, the stomach, even on the right side. The pylorus, which is without appendages, lies to the right of the hæmal spines of the 1st, 2nd and 3rd caudal vertebræ, about half-way up the abdominal cavity. From this point the intestine forms an abrupt bend forwards and downwards to the left side of the rectum, just above the vent, and then turns sharply to the right, upwards and backwards, in a coil that passes into the secondary abdominal cavity on the right side and there extends back for a distance which may sometimes be no more than ${}^1/_7$ of the total length of the body, but occasionally as much as ${}^1/_3$ thereof. The returning part of this coil, in a forward direction, runs along the lower margin of the secondary abdominal cavity, almost to the beginning of the anal fin. At this point the intestine again bends sharply upwards and backwards to form a coil lying on the inner side and to the right of the former coil, and returning by means of its upper part in a forward direction to the rectum, which turns down to the vent. The gall-bladder, which is fairly large, lies at the top of the abdominal cavity proper, on the right side; and just behind and below this bladder lies the spleen, which is of about the same size, between the liver and the coils of the intestine. The kidneys lie at the top of the anterior part of the secondary abdominal cavity on the blind side, and present the appearance of a large, thick and oblong, dark-coloured, glandular body. The peritoneum is black on the eye side. This is also the case with the whole of the inner side of the wall of the gill cavity, with the exception of the hind margin, which is white, at least on the blind side. The cavity of the mouth and the blind side of the peritoneum are white.

The Sole (Sw. *tunga* = tongue) is generally known in Bohuslän as *sula* (*såla*), a name which in sound and meaning represents the Latin *solea*. It is fairly common in the Skager Rack along the coast of Bohuslän, and even enters the Sound, though there, as well as in the Belts, it is one of the rarer Flatfishes (WINTHER). In the south of the Baltic off Abekås, it is sometimes taken in autumn, in Eel-pots, according to NILSSON. On the German side it is taken, though also seldom, as far as the coast of Mecklenburg (MÖB., HCKE). Higher up the Baltic we have no authenticated instance of its occurrence, though it is by no means averse to brackish or fresh water. According to COLLETT its range on the coast of Norway is not known to extend further north than Stadt, in Lat. 62° N. In Scandinavia, however, only individual specimens are taken, and the species never occurs in shoals[a]. The fishermen too, often confuse it with *Drepanopsetta platessoides*, which in some localities is called *tunga*. Off the Skaw it is more common than in Sweden; and most of the Soles brought to Gothenburg are said to come from the Skaw (MALM). Even there, however, the Sole-fishery is far less important than it is farther south. The fishermen of Fredrikshavn, in KRØYER's time, about 1840, used generally to hand over their catch of soles to the dealers without payment, as a kind of return for the spirits and tobacco given them when they came on board to deliver their fish; and the Sole and some other species were, therefore, comprised under the name of *brandy-fish*. Even in the vicinity of Fredrikshavn, however, the trade in fish is now carried on on far different principles; and the Danish fishery in the Cattegat, inside the Skaw, in 1885 for example, produced Soles to a value of £4,430 (79,788 crowns)[b]. This sum is infinitesimally small, however, in comparison with the results of the Sole fishery in the North Sea and on the coasts of Great Britain. According to the statistical reports for the year 1888 the Sole fishery of England and Wales[c] produced fish to a weight of 72,826 cwt. and a value of £378,538. The catch for the same year in Scotland[d] was 12,664 cwt., of a value of £16,512, and in Ireland 3,731 cwt., of a value of £11,383. Thus, the total value of the Sole-fisheries of Great Britain and Ireland for the year 1888 was £406,433. The geographical range of the Sole also extends into the Mediterranean and the Adriatic: off Venice it is very common, according to NINNI[e].

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[a] Gbgs Vet., Vitt. Handl., Ny Tidsföljd, Häftet 1, p. 24.

In habits the Sole essentially resembles the rest of the Flatfishes. It is really a salt-water fish; but like many other members of its family it often makes its way into fresh water, where it is even capable of breeding, according to statements from England. YARRELL states, on the authority of a letter from one of his correspondents, that the Sole frequents the river Arun from the mouth five miles upwards, and remains there the whole year. "It is evident they breed in great numbers in the river from the quantity of small ones about two inches long that are constantly brought on shore when drawing the net for Grey Mullet." The Soles that live in fresh water, are also stated to be thicker (more fleshy) than those from the sea.

During summer the Sole lives in water of a moderate depth, on a sandy or stony bottom, but in winter it retires to deeper water, and does so earlier than the rest of the Scandinavian Flatfishes. "When the winter season comes on," says BUCKLAND, "the soles in the North Sea take up their winter quarters (probably for hybernating purposes) in very deep water. The chief resort of soles in the winter months is the Silver Pits, a very extensive piece of deep water situated between the Dogger Bank and the Well Bank. The greatest depth is to be found at the west end, where there is fifty-six fathoms of water, i. e. 134 feet higher than the Monument. The soundings brought up from here resemble biscuit dust. The Silver Pits (first discovered, I believe, in 1843) are so called on account of the large quantity of fish which were caught when the pits were first discovered. Soles massed themselves together in these pits in a wondrous way, and fabulous stories are told of the sole fishery there[f]."

According to the statements of the fishermen, the spawning-season of the Sole occurs during the summer months, at the end of May or beginning of June. Its food is composed chiefly of small crustaceans, mollusks and fishes. It is also said to devour the roe of other fishes.

In Scandinavia the Sole is generally caught with other Flatfish in nets shot for Plaice. On rare occasions it is taken on the hook. The large catches in the North Sea are made chiefly in the trawl. The flesh is firm, white, and of good flavour. In this respect the Sole ranks beside, in the opinion of many above, the Turbot; but just as the Turbot must be boiled, the Sole, to retain its boasted flavour, must be eaten fried.

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[a] KRØYER states, however, that at the beginning of this century three boats from Gilleleje, which had shot their nets off Hesselö, north of Zealand, took 1,600 Soles at one haul.

[b] Dansk Fiskeriselskabs Medlemsblad, 10:e Juni, 1886, p. 82.

[c] Fish Trades Gazette, vol. VI, No. 295, p. 8.

[d] Ibid., No. 297, p. 8. In this total, however, the Lemon Sole, a closely related, but less valuable species, is included.

[e] Espos. Intern. di Pesca in Berlino 1880, Sez. Ital., Cat., p. 180.

[f] Cf. too HOLDSWORTH, *Deep-Sea Fishing and Fishing Boats*, London 1874, p. 94.

(Ekström, Smitt.)

Subfamily PLEURONECTINA.

Snout not elongated: the lower jaw most prominent. Mouth small and oblique, the gape slightly curved at the sides. Jaw-teeth fewer and smaller on the eye side than on the blind side. Ventral fins situated one on each side of the ventral margin, their rays close together at the base. Eyes large or at least middle-sized. Pseudobranchiæ well-developed. Gill-rakers small or middle-sized, and scattered[a].

The Flatfishes commonest in our waters, grouped round the Flounders proper, range themselves in this subfamily. Only three of Günther's genera (*Pleuronectes, Parophrys* and *Psammodiscus*), containing 30 species according to his *Catalogue*, can be referred to it, all of them, so far as their locality is known, belonging to the temperate and cold parts of the oceans of the Northern Hemisphere, and at least one of them, the Pole (*Pleuronectes cynoglossus*), with a range extending from the littoral zone to a depth of about 700 fathoms. The geographical range of several species also embraces the whole of the Northern Hemisphere. When we reflect too that these fishes also make their way into fresh water, and can thus sustain life under circumstances of the most opposite nature, we may reasonably expect here to find the explanation of the great variability of the characters which has given birth to the distinction of species, in cases where we should probably speak only of local varieties of one single species. This increase in the number of the species has been accompanied by a tendency to establish more genera in the subfamily. But Günther remarks[b], not without reason, that "if we were to attribute to some of the characters the same (generic) value as in other *Pleuronectidæ*, we should be obliged to establish a genus for almost every species, and to separate fishes which evidently form one natural group." We easily find, however, that the distinctions between some of the species are of very different nature from the distinctions between others. Even in the Scandinavian fauna, which contains only five species of this subfamily, we may distinguish in this manner between at least two different groups of species, the one, with its numerous vertebræ and fin-rays and more Sole-like body, indicating a transition to the preceding subfamily, and the other containing the most typical Flounders, the Swedish "*skäddor*." There thus seems to be every reason to recognise this difference as subgeneric.

Genus PLEURONECTES.

Jaw-teeth of moderate size, set in one or two rows, pointed or broad. No palatine or vomerine teeth.

These fishes, which the ancient Greeks called *ψῆτται*, and the Romans *passeres*[c], were ranged by Artedi in the genus *Pleuronectes*[d]. In his writings, however, as in those of Linnæus and their immediate sucessors, this genus corresponded to the modern family *Pleuronectidæ*. The limitation which is generally given to the genus at the present day; was proposed by Günther[e], who adopted Bleeker's[f] suggestion, and separated from the genus those Pacific forms which are distinguished by the persistence, even in adult specimens, of small and pointed jaw-teeth, set in several rows. With this definition the genus *Pleuronectes* contains some twenty species, several of which, however, must still be regarded as imperfectly known.

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[a] In the genus *Psammodiscus*, however, according to Günther, the gill-rakers are close-set.

[b] *Cat.*, l. c., p. 438.

[c] "A colore passerum avium, nam parte supina albicant, prona fusci sunt et terrei coloris, instar passerum avium," Rondelet: *De Pisc.*, lib. XI, cap. VIII.

[d] *πλευρὸν*, side; *νήκτης*, swimmer.

[e] *Cat.*, l. c.

[f] Versl., Mededeel. Akad. Wet. Amsterdam, 13 Deel. (1862), p. 429.

The five species that belong to the Scandinavian fauna may be distinguished as follows:

- *A:* Vertebræ more than 45; rays of the dorsal fin more than 85, of the anal fin more than 70: Subgenus *Glyptocephalus*.
    - *a:* Least depth of the tail less than 8 % of the length of the body. Length of the lower jaw at least about $^2/_3$ of the least depth of the tail. Anal spine present. Rays of the ventral fins 6 .... *Pleuronectes cynoglossus.*
    - *b:* Least depth of the tail more than 8 % of the length of the body. Length of the lower jaw at most about $^1/_2$ of the least depth of the tail. Anal spine wanting. Rays of the ventral fins 5 .... *Pleuronectes microcephalus.*
- *B:* Vertebræ less than 45; rays of the dorsal fin at most 85, of the anal less than 70: Subgenus *Pleuronectes.*
    - *a:* Lateral line of the abdominal region distinctly arcuate. Length of the postorbital part of the head less than 14 %[a] of that of the body .. *Pleuronectes limanda.*
    - *b:* Lateral line of the abdominal region straight or only slightly curved. Length of the postorbital part of the head more than 14 %[b] of that of the body.
        - *aa:* Vertebræ more than 40. Rays of the anal fin more than 46. Length of the peduncle of the tail at the dorsal or the ventral edge less than $^1/_3$ of the postorbital length of the head .... *Pleuronectes platessa.*
        - *bb:* Vertebræ less than 40. Rays of the anal fin less than 46. Length of the peduncle of the tail at the dorsal or the ventral edge more than $^1/_3$ of the postorbital length of the head *Pleuronectes flesus.*

THE POLE (SW. SKÄRFLUNDRAN OR JYDETUNGAN).

PLEURONECTES CYNOGLOSSUS.

Plate XIX, fig. 3.

Body comparatively elongated, like that of the Sole, the greatest depth being usually from 30 % to 36 % of the length. Dorsal and anal fins with especially numerous rays, the former containing about 100—112 and the latter about 90—100 rays. Least depth of the tail less than 8 % (about 6·5—7 %) of the length of the body. Length of the head less than 18 % (about 17—15 %) of that of the body, and the distance between the anal fin and the tip of the snout less than 25 % (about 24—19 %) of the latter. Postabdominal bone (first interhæmal spine of the anal fin) projecting downwards and forwards, in the form of a spine, behind the vent. Rays of the ventral fins, as a rule, 6. Blind side of the head and the preopercular margin of the eye side cavernous, on account of the large muciferous hollows beneath the skin. Lateral line almost straight. Vertebræ about 56. Jaw-teeth close-set incisors, about half as many (9—12) on the eye side as on the blind side (22—24); pharyngeal teeth straight and cylindrical, set in a single row on each of the six upper pharyngeals, and in a double row on each of the two lower ones. Coloration of the eye side grayish russet with grayish blue fins; pectoral fin partly black.

R. br. 7; *D.* 100—115[c]; *A.* 87—100[d]; *P.* 10—12; *V.* 6[e]; *C.* x+14 1. 16[f]+x; *Lin. lat.* 128—130; *Vert.* 56—58.

Syn. *Pleuronectes* (*Cynoglossus*, *Scharretong*), GRONOV., *Mus. Ichth.*, vol. I, p. 14, No. 39; vol. II, p. 11.

Pleuronectes Cynoglossus, LIN., *Syst. Nat.*, ed. X, tom. I, p. 269; FRIES, Vet.-Akad. Handl. 1838, p. 166; NILSS., *Skand. Fn.*, *Fisk.*, p. 623; GTHR, *Cat. Brit. Mus.*, *Fish.*, vol. IV, p. 449; COLL., Forh. Vid. Selsk. Christ. 1874, Tillægsh., p. 147; ibid. (*Glyptocephalus*) 1878, No. 14, p.

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[a] As a rule less than 13 %.

[b] As a rule more than 15 %.

[c] Sometimes 95, according to COLLETT; sometimes 117, according to GOTTSCHE, or 120, according to GOODE and BEAN.

[d] Sometimes 86, according to COLLETT, sometimes 102, according to GOTTSCHE.

[e] Sometimes 5, according to GOTTSCHE.

[f] In a specimen from Halifax (N. S.) there are 19 branched rays in the caudal fin, but only 3 supporting rays above and 2 below.

98; ibid. 1879, No. 1, p. 82; *Norsk Nordh. Exp.*, *Zool.*, *Fiske*, p. 150; Malm (*Pleuronectes*), *Gbgs. Boh. Fn.*, p. 527; Winth., Naturh. Tidskr. Kbhvn, ser. 3, vol. XII, p. 40; Goode, Bean (*Glyptocephalus*), Proc. U. S. Nat. Mus. vol. 1 (1878) p. 19; Hansson, Öfvers. Vet.-Akad. Förh. 1880, No. 4, p. 52; Mor. (*Platessa*), *Hist. Nat. Poiss. Fr.*, tom. III, p. 296; Jord., Gilb. (*Glyptocephalus*), Bull. U. S. Nat. Mus., No. 16, p. 838; Day (*Pleuronectes*), *Fish. Gt. Brit.*, *Irel.*, vol. II, p. 30, tab. CIII; Möb., Hcke, *Fisch. Osts.*, p. 99; Lillj., *Sv.*, *Norg. Fn.*, *Fisk.*, vol. II, p. 386; Gthr, *Voy. Chall.*, *Deep-sea Fish.*, p. 166.

Pleuronectes Saxicola, Faber, Tidskr. f. Naturv., Bd. 5 (1828), p. 244; Isis 1828, p. 877; Gottsche (*Glyptocephalus*), Wiegm. Arch. Naturg., Bd. I, part. 2, p. 156; Kr. (*Platessa*), *Danm. Fiske*, vol. 2, p. 338.

Pleuronectes nigromanus, Nilss., *Prodr. Ichth. Scand.*, p. 55; Schagerstr., Physiogr. Sällsk. Tidskr., Heft. 2, p. 312; Valenc. apud. Gaim, *Voy. Isl.*, *Groenl.*, *Poiss.*, tab. 13.

Platessa pola, Jenyns, *Man. Brit. Anim.*, p. 458, sp. 145; Yarr., *Hist. Brit. Fish.*, ed. 2, vol. II, p. 315; Thomps., *Nat. Hist. Irel.*, vol. IV, p. 197; A. Agass. (*pole flounder*) Bull. Mus. Comp. Zool., Harv. Coll., vol. XV, p. 24.

Platessa elongata, Yarr, l. c., p. 318; Gthr (*Pleuronectes*), l. c., p. 450; Day, Proc. Zool. Soc. Lond. 1879, p. 755, tab. LXI; Gill (*Glyptocephalus*), Proc. Acad. Nat. Sc. Philad. 1873, p. 362.

Glyptocephalus acadianus, Gill, l. c. (vide Goode et Bean, l. c.).

The elongated (narrow elliptical) and thin shape of the body, the large number of rays in the dorsal and anal fins, the cavities in the head (especially on the blind side), and the black colour of the outer half of the pectoral fin on the eye side, all combine to render the Pole easily recognisable and to explain the name it bears in the island-belt of Gothenburg (*Jydetunga* = Jutland Sole). In Scandinavia it attains a length of at least half a metre, while American specimens about 62 cm. long are on record. The greatest depth of the body, which undergoes even relative increase with age, in adult specimens measures on an average $^1/_3$ of the length of the body, but sometimes[a] sinks as low as $^1/_4$ thereof. The males of this species are probably, as a rule, no more elongated than the females[b]. Behind the head the body grows thinner and thinner posteriorly. The Danish fishermen, according to Gottsche, call this species on account of its transparency *Spindelflynder*=Spider (Cobweb) Flounder. The greatest thickness of the head, straight across the upper articulation of the preoperculum, measures only about $^1/_3$ of its length.

In this species, as well as in the next one, the head is smaller than in the rest of our Flatfishes; but in the Pole it is remarkable chiefly for the large cavities which here, as in *Acerina cernua*, are formed by the muciferous hollows of the system of the lateral line. These cavities are most distinct and largest on the blind side. Here there are four round cavities in a row close to the dorsal margin and belonging to the occipital branch of the lateral line on this side; while below these there generally lie five cavities, belonging to the frontoparietal and suborbital branches, four of them in a curved row and the fifth below this row. Four cavities belong to the margin of the preoperculum, one lying between the latter and the lower jaw, on the under surface of which the line is continued by three or four depressions, the two front ones, however, being small and indistinct. On the eye side the occipital branch of the lateral line is of normal structure, and extends upwards and forwards, being distinctly visible along the base of the dorsal fin to a point almost vertically above the middle of the upper eye; but there are distinct muciferous cavities, though smaller than on the blind side, both in the preopercular margin and the lower jaw. On the snout too, we generally find three cavities in front of the eye, the one nearest to the eye being the largest and triangular. At least in one and sometimes in two of these last cavities the skin is pierced by a small round pore. Between them and the lower eye lies the nasal cavity of the eye side with its two nostrils, the anterior of an obliquely truncate, tubular shape, with the truncate (open) side in front, and set almost vertically above the front margin of the lower eye or a little farther forward, the posterior an oblique dermal slit just behind this point, about half-way between the anterior nostril and the front of the raised and narrow, but obtuse, sharply curved, interorbital margin of the forehead. The nostrils of the blind side are like those of the eye side, but their situation is entirely different. On this side the nasal cavity lies high up, at the dorsal margin of the head, in front of the first muciferous cavity of the dorsal margin; and the anterior nostril lies obliquely above the posterior, which has the form of a slit, but is so obliquely set that it is almost parallel to the dorsal margin of the head. The eyes are fairly large. The longitudinal diameter of the upper orbit measures nearly half the length of the cranium from the head of the vomer to the occipital foramen; and the longitudinal diameter of the eyes themselves (the upper eye is somewhat larger than the lower), measured within the dermal folds that serve as eyelids, is about $^{1}/_{3}$ of the total length of the head. Half or a third of the upper eye lies behind the perpendicular from the hind margin of the lower. The mouth is small, the length of the maxillary bones varying between about 3 and $3^{1}/_{2}$ %[a] of that of the body, and the length of the lower jaw between about 5 and 6 %[b] thereof. The transverse palatal folds are well-developed, though not large, both in the upper jaw and the lower. The lower jaw is furnished with a well-developed chin protuberance under the symphysis. The lips are fleshy, but not tumid. The jaw-teeth, which are pointed in young specimens[c], subsequently become chisel-shaped. The gill-rakers are well-developed but scattered, and set in a single row, containing about 8 on the first branchial arch. On the lower pharyngeals, which are narrow and long (like branchial arches), these spines are exchanged for a double row of conical, obtusely pointed teeth. The roof of the palate, as usual, is truncate posteriorly, with a deep pharyngeal cavity behind it, into which is fitted the upper pharyngeal apparatus, consisting of three pairs of pharyngeals directed outwards and backwards, each with a row of six or seven conical teeth. The tongue is small and narrow, but the hyoid surface (copular part) is continuous and fleshy, widening into a triangle behind. The pseudobranchiæ are set just behind the upper articulation of the hyomandibular bones, at the extreme front of the pharyngeal cavity mentioned above. The preoperculum of the eye side is more obtuse-angled than that of the blind side, the latter being also furnished with broader margin and much larger muciferous cavities. The operculum forms an almost equilateral triangle, as in most of the Flatfishes, with the hind upper corner rounded and the lower posterior margin incised. The suboperculum is as usual elongated backwards and upwards to a point, which fills this incision, the suboperculum thus forming the greater part of the hind margin of the gill-cover, up to the obtuse flap of this margin. The interoperculum is attenuated anteriorly. The branchiostegal membranes are as usual free, but inferiorly united to each other in a broad transverse fold, where the tips of the first two branchiostegal rays touch. In ordinary cases this transverse fold covers the point of the clavicular bones; but when the gill-cavity is strongly expanded, the fold is drawn so tight, into the angle of the urohyoid bone, that the point of the clavicular bones is externally visible as a forward process[d].

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[a] Goode and Bean (l. c.) mention a specimen 114 mm. long in which the greatest depth of the body was no more than $24^1/_2$ of the length. The highest proportion given by these writers is $37^1/_2$ %.

[b] In a male from Bohuslän, 411 mm. long, the greatest depth of the body is 30·6 % of the length, in a female 418 mm. long 32·5 %; but in another male 378 mm. long the greatest depth is 33·6 % of the length.

[c] It was these cavities, which are supported in the cranium by upright, thin, osseous bars and ridges, that suggested to Gottsche the establishment of the genus *Glyptocephalus* (γλύφω, *to hollow*).

The dorsal fin begins above the middle or the front of the upper eye, exactly at the dorsal margin or with the first ray alone slightly drawn over towards the blind side, and extends back to a point the distance between which and the caudal fin is about half the diameter of the eye. The dorsal fin is evenly rounded, the longest rays being situated at the middle of its length, and their length being about equal to the vertical height of the preoperculum. The anal fin, which begins behind the anal spine, a little behind the perpendicular from the insertion of the pectoral fins and below the 16th, 17th, or 18th ray of the dorsal fin, at a distance from the tip of the snout that measures about 19—24 % of the length of the body, is of the same shape and height and ends in the same manner as the dorsal fin. All the rays in the dorsal and anal fins are simple[e], articulated, and undivided. The pectoral and ventral fins are pointed, seem generally to be longer in the males than in the females[f], and are always somewhat longer on the eye side than on the blind side. In the pectoral fins the two or three uppermost rays and the lowest ray of all are undivided; in the ventral fins at least the first (outermost) ray is undivided or only indistinctly branched. The caudal fin, the length of which, measured at the middle, is from 13 to 16 % of that of the body, is rounded or obtusely pointed at the hind margin. It contains between 14 and 16[a] branched rays and an inconstant number (3—5 on each side) of supporting rays.

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[a] On the blind side, according to our measurements, at least 3·3 % and at most 3·7 %, on the eye side at least 2·9 % and at most 3·4 %.

[b] On the blind side, according to our measurements, at least 5·3 % and at most 5·9 %, on the eye side at least 4·7 % and at most 5·6 %. On the blind side we have found the length of the lower jaw (in specimens between 378 and 516 mm. in length) to vary between $81^{1}/_{2}$ and $84^{1}/_{2}$ % of the least depth of the tail; on the eye side between 72 and 83 % thereof. According to Krøyer's measurements, however, the last proportion may be as low as 66·7 %.

[c] "Conical and separated:" Goode and Bean, l. c.

[d] The urohyoid bone is united by a long ligament to the hyoid bone, but is closely joined to the clavicular bones.

[e] "Sometimes," says Gottsche, however, "the last rays of the dorsal fin are branched."

[f] In three males, between 378 and 516 mm. long, the minimum length of the pectoral fins was 9·2 % and the maximum 12·6 % of the length of the body, while in the case of the ventral fins these proportions were respectively 5·5 and 7·2 %. In three females, between 418 and 470 mm. long, the minimum length of the former fins was 7·6 % and the maximum 8·8 % of the length of the body, while in the case of the ventral fins these proportions were respectively 5 and 5·1 %.

The scaly covering of the body is abundant and compact, but thin, consisting of imbricated, cycloid[b] scales, which are rather small on the forepart of the body, but fairly large posteriorly and on the caudal fin[c]. The scales of the blind side are generally somewhat smaller than those of the eye side. The only scaleless parts are the snout and the under jaw (at least the greater part thereof), the branchiostegal membranes, the inner surface of the paired fins, and the tops of the rays in these fins as well as in the dorsal and anal fins. Krøyer's estimate of the scales of the lateral line is "more than 120;" Goode and Bean counted between 109 and 150 transverse rows of scales on the blind side and between 110 and 140 on the eye side. The lateral line is straight, and fairly closely follows the middle of the sides, or sometimes, according to Goode and Bean, forms a distinct curve on the abdominal part, above the pectoral fins[d].

The abdominal cavity proper is small[e], but contains the whole of the intestinal canal with the exception of one coil, which, together with the elongated spleen, passes into[f] the secondary abdominal cavity of the eye side, where it lies upon the upper part of the sexual organs. Two well-developed pyloric appendages, the length of which is greater than the width of the stomach and intestine, are set behind the pylorus, which lies at the lower posterior corner of the abdominal cavity. The intestine is sharply divided from the stomach, and has much thinner walls than the latter. The liver seems to vary considerably in size[g]. In this species too, however, it covers the greater portion of the intestines. On the blind side the peritoneum is white or clouded with black, on the eye side black, which latter colour also extends over the anterior part of the secondary abdominal cavity of the eye side. This cavity, as well as that of the blind side, is of a considerable length[h] in the females, the length of each of these cavities, in which the ovaries are contained, being only slightly less than half the length of the body. The number of the eggs is very considerable[i]. The testes of the males probably do not attain so great a size as the ovaries. In two males (one taken in March, the other at an unspecified time of year) the testes are not even so large as the liver, and in shape only slightly more elongated than an equilateral triangle; and it is only on the eye side that the secondary abdominal cavity is somewhat elongated, to receive the coil of the intestine[j]. The vent is situated at about the middle of the length of the pectoral fins when folded, or somewhat further forward.

The coloration of the Pole is variable like that of the other Flatfishes. The original of our figure, a female 445 mm. long, which was taken by Mr. C. A. Hansson in Starekil off Strömstad, on the 21st of January, 1888, was of a light grayish russet on the eye side, with streaks of a darker colour, when it reached the Royal Museum. On the right side of the vertical fins and on the right ventral fin this colour shaded into grayish violet, but in the anterior part of the dorsal and anal fins, as well as in the outer half of the caudal fin and in the pectoral fin of the eye side, the fin-membrane was black, and the tips of the rays of the dorsal and anal fins were yellowish white. The hind part of the branchiostegal membrane was black, the pupil blackish blue, the iris golden. The blind side of the fish was white, finely punctated with black dots. The museum-specimens preserved in spirits generally acquire the darker brown colour shown in Valenciennes' figure in Gaimard (l. c.).

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[a] In one specimen from Halifax (N. S.) 19 branched rays, 3 supporting rays above and 2 below.

[b] According to Day the scales on the eye side of the body are "feebly ctenoid." Faber seems also to have met with similar specimens. Cf. Gottsche, l. c.

[c] In a specimen 470 mm. long the largest scales (on the tail) of the eye side are about $6^1/_2$ mm. long, while the scales on the forepart of the body (on the back above the pectoral fin of the eye side) are about $2^1/_2$ mm. long. In a specimen 516 mm. in length the largest scales are $7^1/_2$ mm. long.

[d] This also applies to the specimen from Halifax which the Royal Museum has received from the Smithsonian Institution.

[e] In a female 470 mm. long its length is 40 mm. and its depth 60 mm.

[f] In the female just mentioned the coil of the intestine extends into this secondary abdominal cavity for a distance of 37 mm.

[g] Krøyer describes it as rather small; but in the above female the liver occupies 45 mm. of the depth of the abdominal cavity, and in a male 411 mm. long, in which the abdominal cavity is 38 mm. long and 42 mm. deep, the liver occupies 26 mm. of this depth — in each case on the left side.

[h] In the female just mentioned the left ovary is 198 mm. long, and its tip extends to a point only 62 mm. distant from the end of the anal fin; the right ovary is 231 mm. long, and its tip is only 48 mm. distant from the end of the anal fin.

[i] In ovaries so large the eggs were rather small, their diameter being only $^1/_2$ mm. According to Thompson, however, the eggs of this species may attain a diameter of $1^3/_5$ mm.

[j] In one of the above males, 411 mm. in length, the secondary abdominal cavity of the eye side is 41 mm. long, and in a male 516 mm. in length (from Halifax) it is 97 mm. long.

The range of the Pole in the Atlantic is extensive. The species is known from the extreme north of Norway and from Iceland to the vicinity of Carolina (N. America) and the west coast of France. In addition to this wide geographical range it also has an extensive bathymetric distribution, for it lives in water of a depth varying from about 10 to 730 fathoms[a]. The advanced development of the muciferous cavities in the head is also, we need hardly say, of ordinary occurrence in deep-sea fishes[b]. It is, therefore, extremely probable that the Pole has its true home in deep water, and for some reason or other migrates thence to the higher marine regions. If this is the case, we can easily understand why the species is comparatively rare in Scandinavia. Along the whole coast of Bohuslän, however, it is taken occasionally, generally in Flounder-nets, at a depth of from 10 to 20 fathoms. According to Malm it there prefers a soft, grayish, sandy bottom; but according to Faber it has received the name of *Skjærising* (cf. the Swedish name *Skärflundra* = Rock Flounder) of the fishermen of Hirsholm and the Skaw, where it is commoner than in Bohuslän, because it is generally found on the reefs. Off Kullen, too, according to Schagerström, it bears this Danish name among the fishermen. In the north of the Sound and southwards to the neighbourhood of Landskrona it is sometimes met with, say both Schagerström and Winther. It has twice (in 1875 and 1880) been found in the extreme west of the Baltic (Möbius and Heincke), but is unknown further in. It is also said to be unknown on the shelving west coast of Jutland (Krøyer and Winther). According to Collett it is caught in Christiania Fjord all the year round, but mostly during the autumn months, and in Trondhjem Fjord it is stated not to be rare. The species was found by the Norwegian Arctic Expedition in West Fjord at a depth of 150 fathoms, on a sandy bottom, where the temperature at the bottom was 41° Fahr., and in Tana Fjord (East Finmark) at a depth of 127 fathoms, on a bottom of mud and clay, where the bottom temperature was 37° Fahr. According to Goode and Bean the corresponding temperature at which the Pole has been found on the other side of the Atlantic, is between 34° and 45° Fahr. Further south on the European side the Pole occurs, though not frequently, round the coasts of Great Britain and Ireland. In the English Channel, according to Moreau, it is "uncommon" and off Arcachon "extremely rare."

The nature of the Pole's food is shown by its teeth: with the jaw-teeth it cuts or tears away its prey from the bottom, and with the blunt, conical pharyngeals it crushes the thin shell of its victim. Pennant found small crustaceans and starfish in its stomach, and Krøyer small shellfish and worms.

The spawning-season of the Pole in England, according to Day, occurs in early summer, in May and June; in Scandinavia both Krøyer and Malm found females with the development of the ovaries so advanced at the end of June that the spawning-season might be expected in August.

As the Pole is not caught anywhere in any considerable quantity, its preference for deep water rendering it difficult to reach with nets, while, like the rest of the true Flounders, it seldom takes a bait, it is, therefore, of no great economical importance[c]. Its flesh, however, is excellent, and thus in many places it bears local names that range it by the side of the Sole, to which it is also more closely approximated by the form of the body than any other of the true Flounders. "It is without doubt our most delicious Pleuronectoid," says Malm, "and is usually very fat, a circumstance which we should hardly expect from the thinness of its body at the edges." Lilljeborg was informed by Mr. C. A. Hansson that, on account of its fine flavour, the fishermen of Strömstad call it *Sockerskädda* (Sugar Dab).

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[a] Goode and Bean, Bull. Mus. Comp. Zool., Harv. Coll., Cambr., vol. X, No. 5, p. 195.

[b] Günther, *Rep. Chall. Exped., Deep. Sea Fishes*, p. XXVI.

[c] In the winter of 1891—92 the Pole was sometimes brought from Gothenburg to the fish-market at Stockholm. There it was sold under the name of Sole.

THE LEMON DAB OR SMEAR DAB (SW. BERGSKÄDDAN).

PLEURONECTES MICROCEPHALUS.

Plate XX, fig. 1.

Body less elongated than in the preceding species, the greatest depth being generally from 35 to 38 %[a] *of the length. Dorsal and anal fins with numerous rays, the former with about 90—94, the latter with about 72—75. Least depth of the tail more than 9 % (about 9·2—10·2 %) of the length of the body. Length of the head less than 17 % (about $16^{1}/_{2}$—15 %*[b]*) of the length of the body, and the distance between the anal fin and the tip of the snout less than 24 % (about $22^{1}/_{3}$—$19^{1}/_{5}$ %) thereof. Postabdominal bone not projecting in a spine behind the vent. Rays of the ventral fins as a rule 5. Head without externally visible muciferous cavities. Lateral line slightly curved above the pectoral fins, but with this exception straight. Vertebræ about 48. Jaws furnished with close-set incisor-like teeth, few (at most 2 or 3) or none on the eye side, and at most about 17 on the blind side; pharyngeal teeth comparatively weak and scattered, pointed, and set in a single row on each of the six upper pharyngeals and in a double row on both of the lower pharyngeals. Coloration of the eye side reddish or yellowish brown; pectoral fin of the same colour as the body.*

R. br. 7: *D.* 87[c]—98; *A.* 72[d]—75; *P.* 10; *V.* 5[e]; *C.* $x+14$ l. $15+x$; *Lin. lat.* ca 120[f]; *Vert.* 48 l. 49[g].

Syn. *La vraie limandelle*, Duh., *Tr. d. Pêch.*, part. II, tom. III, sect. IX, p. 268, tab. VI, figg. 3 et 4.
Pleuronectes kitt (p. p.) Walb., *Ichth. Art.*, III, p. 120.
Pleuronectes microcephalus, Donov., *Brit. Fish.*, vol. II, tab. 42; Fr., Vet.-Akad. Handl. 1838, p. 173; Kr. (*Platessa*), *Danm. Fiske*, vol. II, p. 316; Lillj. (*Pleuronectes*), Vet.-Akad. Handl. 1850, p. 334; Nilss., *Skand. Fn.*, *Fisk.*, p. 609; Ekstr., v. Wright, *Skand. Fisk.*, ed. 1, p. 217, tab. 56; Gthr, *Cat. Brit. Mus.*, *Fish.*, vol. IV, p. 447; Coll., Forh. Vid. Selsk. Christ. 1874, Tillægsh., p. 145; Cederstr., Öfvers. Vet.-Akad. Förh. 1876, No. 4, p. 66; Malm, *Gbgs*, *Boh. Fn.*, p. 526; Winth., Naturh. Tidskr. Kbhvn, ser. 3, vol. XII, p. 40; Steind., Stzber. Akad. Wiss. Wien, Math. Naturw. Cl., Bd. LXXX, I, 1880, p. 165 (p. 47, sep); Mor. (*Platessa*), *Hist. Nat. Poiss. Fr.*, tom. III, p. 294; Day (*Pleuronectes*), *Fish. Gt. Brit.*, *Irel.*, vol. II, p. 28, tab. CII; Möb., Hcke, *Fisch. Osts.*, p. 98; Lillj., *Sv.*, *Norg. Fn.*, *Fisk.*, vol. II, p. 402.
Pleuronectes Quenselii, Hollberg, *Boh. Fisk.*, Gbgs Wett., Witt. Samh. N. Handl., part. IV, p. 59 cum tab.
Pleuronectes quadridens, Fabr., D. Vid. Selsk. Afh., part. I, p. 39; Faber, Isis, 1828, p. 884; Id., *Fisch. Isl.*, p. 138.
Pleuronectes microstomus, Faber, *Isis* 1828, p. 886; Tidskr. f. Naturv. Kbhvn, Bd. 5 (1828) p. 245; Nilss., *Prodr. Ichth. Scand.*, p. 53; Schagerstr., Physiogr. Sällsk. Tidskr. 1837, H. 3, p. 310.
Pleuronectes Pola, Cuv., *Règne Anim.*, ed. II (1829), p. 339.
Pleuronectes Cynoglossus, Nilss., Prodr., l. c.
Microstomus latidens, Gottsche, Wiegm. Arch. f. Naturg., Jahrg. I, Bd. 2, p. 150.

Obs. It is scarcely probable that Pennant's *Smear-Dab* (*Pl. lævis*, Shaw) belonged to this species, for the dorsal fin, according to Pennant (*Brit. Zool.*, 1776, III, p. 202), contained 79 rays, the greatest depth of the body was 61 % of the length, and "the lateral line was much incurvated for the first two inches from its origin." That Pennant's fig. 106 (representing a *Zeugopterus punctatus*) does not belong to this species, has already been remarked by Fries. Jago's *kitt* (Ray: *Syn. Pisc.*, p. 162, fig. 1) probably belonged to this species[h]; and Wahlbaum's *Pl. kitt* would thus enjoy the right of priority as a specific name (cf. Jordan and Goss, Rep. Comm. Fish., Fisher. 1886, p. 299) if its establishment had not been based as much on Pennant's authority as on Jago's.

The average length of the Lemon Dab in Scandinavia is about 20—25 cm. The largest specimen found by Ekström in Bohuslän was 40 cm. long, and the largest specimen Lilljeborg had seen, 46 cm. long. Thus it is usually smaller than the preceding species, which it resembles pretty closely in the form of the body and the other characters. However, the absence of the anal spine, the tumid, red lips, the redder and more spotted coloration, the smaller scales — especially on the rays of the dorsal and anal fins, where the scales are set in 7 or 8 rows — and lastly the abundant mucous secretion of the skin (the origin of the name of Smear Dab), all combine to render this species easily recognisable.

The body is of an oblong, oval shape and generally deeper than in the preceding species, the greatest depth of the body, which occurs at its middle (excluding the caudal fin), being about $^2/_5$ of the total length to the end of the caudal fin[a]. The greatest thickness of the body always lies behind the head (in the abdominal region or the anterior part of the tail), and is more than $^1/_3$ of the length of the head[b].

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[a] From 32 to 40 %, according to Kroyer.
[b] Sometimes $14^{1}/_{2}$, according to Kroyer, or even 14, according to Gottsche.
[c] Sometimes 85, according to Collett.
[d] From 70—76, according to Day and Lilljeborg.
[e] Sometimes 6, according to Gottsche.
[f] Sometimes 110, according to Kroyer, or 130, according to Day.
[g] From 46 to 48, according to Gottsche.
[h] Cf. Couch, *Fish. Brit. Isl.*, vol. III, p. 187.

The head is small, its length being always somewhat less than that of the caudal fin, and varying in full-grown specimens between 15 % (according to GOTTSCHE 14 %) and $16^1/_2$ % of the total length of the body, or between 18 and 20 % of the length to the base of the caudal fin. The mouth is small, the gape being scarcely curved at all; and the jaws are of equal projection and furnished with round, thick lips. The length of the lower jaw varies between 4 and 5 % of the length of the body or about 40 and 53 % of the least depth of the tail. The jaw-teeth are even, broad, and close-set in a single row; they are present in both jaws, but oftenest, in the upper jaw at least, only on the blind side. The eye side of the jaws is toothless or sometimes furnished with 1—3 teeth. Sometimes one or two of the front teeth are longer than the rest. The upper pharyngeal teeth are comparatively few, 3 or 4 on each of the three upper pharyngeals on each side, and are imbedded in a thick, loose skin on the roof of the pharynx. In shape they are flat, curved, triangular, and sharply pointed, like miniature Squaloid teeth. On the lower pharyngeals they are more scattered and narrower, more dagger-like[c]. The gill-rakers are middle-sized, setiform, and fairly close-set: we have found their number on the first branchial arch to be 22. The gill-openings are uncommonly small, partly because they do not extend higher than the top of the base of the pectoral fins — the entire upper margin of the opercula is united by the skin to the body — partly because the branchiostegal membranes are in great part coalescent inferiorly, forming a fold upwards and inwards that fits into the bend of the urohyoid bone, above the point of the lower extremity of the clavicular bones. To this folding of the branchiostegal membranes is due the peculiarity that the last three of the seven branchiostegal rays lie close together under the margin of the gill-opening; and as the first branchiostegal ray is small and almost invisible, the casual observer finds only three branchiostegal rays on each side. On the eye side of the body the margin of the gill-cover has a somewhat thick, orange rim, and a similar rim appears on the clavicular bone (behind the margin of the gill-opening), in front of the base of the pectoral fin. The eyes are set on the right side, are large and very prominent, and lie so close together that they are separated only by a sharp osseous ridge. The longitudinal diameter of the upper orbit is fully half the length of the cranium from the head of the vomer to the large occipital foramen; but the eyes themselves are so covered with dermal folds that the visible part of the eye is comparatively small. During the growth of the fish from 20 to 30 cm. the length of the visible part of the upper eye diminishes, according to KRØYER's measurements, from $28^1/_2$ to $19^1/_2$ % of the length of the head or, according to our measurements, from $26^1/_2$ to $21^1/_3$ % thereof. The lower eye, which is somewhat smaller than the upper, lies only a little further forward. The nostrils resemble those of the preceding species. They lie fairly near each other, on the eye side nearly in a line with the corner of the mouth and almost between the eyes. The nostrils of the blind side lie almost exactly at the dorsal edge of the snout, in front and to the right of the beginning of the dorsal fin, nearly in a line with the anterior margin of the upper eye.

The scales cover both sides of the body, the head (excepting the eye side of the snout), the rays of the vertical fins, the outer side of the base of the pectoral fins and of half the ventral fins, and sometimes a part of the inner side of the last pair of fins as well. They are thin, smooth at the margin, oval, and (on the body) imbricated. On the head they are nearly round, smaller than on the body, and not imbricated. The lateral line is straight, with a slight, but distinct, arched curve above the pectoral fins. This arch seems generally to be higher on the blind side than on the eye side, but its height and shape are subject to individual variations.

The dorsal fin begins somewhat behind the anterior margin of the upper eye, but distinctly on the blind side, and extends in an arcuate shape nearly to the caudal fin. The distance between these fins is less than $^1/_4$ of the least depth of the tail. As a rule the dorsal fin contains from 87 to 98 rays, all simple, with soft, bent tips. The anal fin in shape resembles the dorsal, begins just behind the vent, at a distance from the tip of the snout that measures between 19 and 22 % of the length of the body, and ends exactly opposite the termination of the dorsal fin. The caudal fin is fairly long — during the growth of the body from 15 to 30 cm., its length at the middle varies between 18 and 16 % of the length of the body — and rounded at the tip. It contains 14 or 15 branched rays, and 2 or 3 supporting rays at either margin.

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[a] In this respect this species is more variable than the preceding one. According to our measurements of 6 specimens between 15 and 31 cm. long, from Bohuslän and Norway, the greatest depth of the body varies between 35 and 38 % of the length to the end of the caudal fin, or $42^1/_2$ and 46 % of the length to the base of the caudal fin, the proportions being highest in the largest specimens. According to GOTTSCHE the former proportion varies between $36^1/_2$ and 45 %, and according to KROYER between 32 and 40 %.

[b] According to our measurements the greatest thickness of the body varies between 34 and 40 % of the length of the head, according to KROYER's measurements between 40 and 43 % thereof.

[c] KROYER has found them to be set in two rows. In our specimens they are set in a single row.

The pectoral fins are almost elliptical. The pectoral fin of the blind side is only slightly shorter than that of the eye side or equal in length to the latter, the length of which is about equal to the least depth of the tail or the length of the longest rays of the dorsal fin. One, two or three of the uppermost rays are simple, the others, usually with the exception of the lowest ray, branched. The ventral fins are small and contain but few rays, their number varying, however, between 4 and 6; the outermost ray and, as a rule, the innermost are simple, the others branched. No constant sexual distinction can be drawn from the length of either the pectoral or the ventral fins.

The coloration of the body in new-caught, young specimens is red, marbled with blackish brown. In very old specimens, or when the fish is dead, the coloration grows darker, and generally becomes yellowish gray marbled with grayish brown. The blind side is always pure white, in exceptional cases with some grayish brown spots at the base of the caudal fin. Only seldom do we find the body adorned here and there with scattered, simple, or large, ocellated spots of a bluish or greenish colour. The fins always retain the colour of the body, though the tips of the anterior rays both in the dorsal fin and the anal are always white. We have already noticed the carnation lips and the orange rim of the gill-cover. The iris is brassy yellow, and the pupil greenish blue.

The internal organs almost exactly resemble those of the preceding species. The peritoneum is more or less dark on the eye side and on the blind side faint brassy yellow or white. Only one coil of the intestine enters the secondary abdominal cavity of the eye side. There are four pyloric appendages of various sizes. The length of the intestinal canal is about equal to that of the body. The liver is large and divided into four lobes, the gall-bladder also large, and the spleen, which is long and triangular, lies as in the preceding species. The secondary abdominal cavity of the eye side, in a female 28 cm. long, measures 38 % of the length of the body, and extends back to the interhæmal spine of the 20th ray in the anal fin, counting from behind; while the length of the abdominal cavity proper is only about $13^1/_2$ % of that of the body.

On the European side of the Atlantic the geographical range of the Lemon Dab is about the same as that of the preceding species, extending from the White Sea to the neighbourhood of Arcachon on the west coast of France, and to Iceland. On the other hand, to the best of our knowledge, it does not descend into very deep water. Like the Pole it has been found once or twice in the south-west of the Baltic, off Kiel; but it does not enter the Baltic proper. According to SCHAGERSTRÖM it is not unfrequently met with in the Sound. It is known by the fishermen of Kullen, on account of its thick lips, as *pluddermun* (Babble-mouth), and by the fishermen of Landskrona as *monflundra* (Mouth-flounder). It is also taken frequently, according to GOTTSCHE, by the fishermen of Zealand, off Gilleleie and Skovshoved, where it is called *stensugare* (Stone-sucker). The name of *mareflundra* (Sea-flounder) is applied by the fishermen of the Sound to almost all the less known Flatfishes, according to SCHAGERSTRÖM. Furthermore, the nomenclature employed by our fishermen is so wanting in accuracy that the Lemon Dab also goes by the name of *tunga* (Sole). It prefers a stony and rocky bottom, and is, therefore, known in the island-belt of Tjörn as *bergskädda* (Rock-dab), and in the north of Bohuslän, according to CEDERSTRÖM, as *bergflundra* (Rock-flounder). Off Bergen, where it is taken in large numbers, it bears the name of *sandflundra*, according to NILSSON. It lives on mollusks, worms, and crustaceans; and its pharyngeal teeth seem especially adapted to the last two kinds of food. EKSTRÖM found in its stomach some sprigs, about an inch long, of *Fucaceæ* (*Furcellaria fastigiata*, *Halidrys siliquosa* etc.), but he was probably right in his assumption that they had been swallowed together with the food, more than for the sake of any nourishment they might afford. In Bohuslän the spawning-season of the Lemon Dab occurs in June. It is generally taken in Flounder-nets together with the Plaice, but in Scandinavia it is by no means so common as the latter. On rare occasions it is caught in the seine and on the hook. The flesh is flabby and inferior to that of the Plaice.

In the basin of the Atlantic the last two species, *Pleuronectes cynoglossus* and *Pl. microcephalus*, form, as we have mentioned, a distinct division of the genus, a branch of the true Flounder-type, advancing in a direction which shows the affinity with the subfamily of the Soles. BONAPARTE proposed[a] to establish a special genus, *Cynicoglossus*, for the Lemon Dab, with its equally prominent jaws, thick lips, and without anal spine. In the Pacific, on the west coast of North America, this genus and *Glyptocephalus* are each represented by one species, which, according to LOCKINGTON's descriptions[b], has a striking resemblance to its Atlantic congener. In the market of San Francisco both are sold under the name of Sole. The *Glyptocephalus* species (*Gl. zachirus*) is distinguished, however, from our Lemon Dab by the large size of the pectoral fins, which on the eye side may even attain a length equal to $^1/_4$ of that of the body; and the *Cynicoglossus* species (*C. pacificus*) has an extremely shallow body, the greatest depth being only about 26—30 % of the length. In the Atlantic, as we have seen, *Glyptocephalus* is distinguished by shorter pectoral fins and a relatively shallower body than is generally the case in *Cynicoglossus*. In the Pacific the relations are reversed. Here we find a substitution of the characters for each other which in a way shows the near kinship between these forms. The next species, however, will show that there is no wide gap between these two genera and the true genus *Pleuronectes*, in its most restricted meaning. But, in spite of the fact that the series is so nearly unbroken, it has also been proposed to establish, for the species which group themselves round the following species, a distinct genus, *Limanda*, characterized by the sharp arcuation of the anterior part of the lateral line.

(EKSTRÖM, SMITT.)

THE COMMON DAB (SW. SANDFLUNDRAN).

PLEURONECTES LIMANDA.

Plate XX, fig. 3.

Body oval, the greatest depth of the body in adult specimens varying between 36 and 42 %[c] of the length thereof. Dorsal fin with at most about 80 (65—80) rays, anal with at most about 60 (50—61). Least depth of the tail generally more than 8 % (between 8 and 9 %) of the length of the body and about 40 % (36—44 %) of the length of the head. Length of the head more than 18 % (in full-grown specimens 22—19 %) of the length of the body, and the distance between the anal fin and the tip of the snout more than 25 % (in full-grown specimens from 33 to 27 %) of the length of the body. Anal spine behind the vent present. Rays of the ventral fins 6. Head without muciferous cavities. Lateral line sharply arcuate in the abdominal region (above the pectoral fins). Vertebræ 39 or 40. Jaw-teeth close together at the base, slightly compressed, conical (the crowns being, therefore, some distance apart), and bluntly pointed, about half as many on the eye side as on the blind side; pharyngeal teeth almost exactly the same as in the preceding species; lower pharyngeals also resembling branchial arches. Coloration of the eye side usually yellowish brown, with lighter spots; pectoral fin of the same colour as the body.

R. br. 7; *D.* 65—80; *A.* 51—61[d]; *P.* 10 l. 11[e]; *V.* 6[f]; *C.* x+12 l. 13+x; *L. lat.* ca 90; *Vert.* 39 l. 40.

Syn. Passer asper sive squamosus (qui a Gallis *limande* vocatur): RONDEL., *De Pisc.*, lib. XI, cap. IX. *Pleuronectes* oculis a dextra, squamis asperis, spina ad anum, dentibus obtusis, ART., *Gen.*, p. 17; *Syn.*, p. 33; *Spec.*, p. 58.

Pleuronectes Limanda, LIN., *Syst. Nat.*, ed. X, tom. I, p. 270; QVENS., Vet.-Akad. Handl. 1806, pp. 54 et 220; SWARTZ, *Sv. Zool.*, No. 16; FABER, Isis 1828, p. 880; Tidskr. f. Naturv. Kbhvn, V (1828), p. 245; NILSS., *Prodr. Ichth. Scand.*, p. 56; SUNDEV., v. WR., *Skand. Fisk.*, ed. 1, p. 150, tab. 34; KR., *Danm. Fisk.*, vol. II, p. 298; LILLJ., Vet.-Akad. Handl. 1850. pp. 309 et 333; NILSS., *Skand. Fn., Fisk.*, p. 627; GTHR, *Cat. Brit. Mus., Fish.*, vol. IV, p. 446; LINDSTR., *Gotl. Fisk.* (Gotl. L. Hush. Sällsk. Årsber. 1866) p. 23; COLL., Forh. Vid. Selsk. Christ. 1874, Tillægsh., p. 146; MALM, *Gbgs, Boh. Fn.*, p. 525; WINTH., Naturh. Tidskr. Kbhvn, ser. 3, vol.

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[a] *Iconogr. Fn. Ital.*, tom. III (*Pesci*), No. 98 (d'ordine per la legatura), *Platessa passer.*

[b] Proc. U. S. Nat. Mus., vol. 2 (1879), p. 86.

[c] According to DAY sometimes nearly 43, but this in a specimen which he believed to be a hybrid between this species and one of the two following species.

[d] Sometimes 50, according to GOTTSCHE; sometimes 62, according to LILLJEBORG.

[e] On the blind side sometimes 9. According to ARTEDI sometimes 12 on the eye side.

[f] Sometimes 5.

XII, p. 39; Benecke, *Fisch., Fischer., Fischz. O. u. W. Preuss.*, p. 95; Day, *Fish. Gt. Brit., Irel.*, vol. II, p. 31, tab. CIV; Mela, *Vert. Fenn.*, p. 308, tab. IX; Möb., Hcke, *Fisch. Osts.*, p. 96; Lillj., *Sv., Norg. Fn., Fisk.*, vol. II, p. 394.

Pleuronectes platessoides, Faber, *Fisch. Isl.*, p. 140.

Limanda vulgaris, Gottsche, Wiegm. Arch. f. Naturg., vol. I, Bd. 2, p. 160; Mor., *Hist. Nat. Poiss. Fr.*, tom. III, p. 289.

Limanda oceanica, v. Bemm., in Herkl.. *Bouw. Fn. Nederl.* III, p. 328.

On the coasts of Scandinavia the usual length of the Dab is between 24 and 28 cm., and scarcely ever more than 30 cm.[a] The greatest depth of the body in full-grown specimens, more than 15 cm. long, varies between about 45 and 51 % of the length from the tip of the snout to the base of the caudal fin; while in younger specimens, even when they have attained a length of 6 cm., this proportion may be as low as 37 %. The length of the head is about $^1/_4$—the variations run between 23 and 27 % — of the distance between the tip of the snout and the base of the caudal fin; and the length of the caudal fin at the middle is from 17 to 19 % of the total length of the body.

The shape of the body is an unbroken oval, distinguished from that of the preceding species of this genus by the circumstance that the tail is attenuated behind the greatest depth of the body rather more sharply and to a greater length. The body is deepest a little behind the end of its first third, at about the 28th, 29th or 30th ray of the dorsal fin. The curves of the upper and lower contours are alike, and even the profile of the head is even, with the exception of a marked depression at the eyes.

In other respects the head deviates only slightly from the structure it possesses in the preceding and following species. Its greatest thickness, which is generally the greatest thickness of the body as well, measures about 7 or 8 % of the length of the body or about 35—42 % of its own length. The eyes are set fairly close together — the external breadth of the flat ridge between them, at its narrowest part, measuring about $^1/_4$ of the length of the orbit — and are of fairly equal size, the lower projecting slightly in front of the upper, which is set so high that part of it overtops the superior profile of the head. In the skull the length of the upper orbit measures less than $^1/_2$ (about 44 %) of the distance between the head of the vomer and the occipital foramen. The eyes themselves measure about 5 %[b] of the length of the body or 23 or 24 %[c] of the length of the head. In youth, as usual, the eyes are comparatively larger[d]. The nostrils are of about the same form and position as in the preceding species; but even the posterior nostril of the eye side, where both nostrils lie in front of the perpendicular from the anterior margin of the eyes, has its margin somewhat raised in a tubular form. The anterior nostril of the blind side, with a fairly large dermal flap, lies a little in front of the perpendicular from the anterior margin of the upper eye, the posterior, without any elevation of the margin, just behind this perpendicular. The mouth is small, the maxillary bone of the eye side scarcely extending back to the perpendicular from the anterior margin of the pupil. The lower jaw projects slightly in front of the upper. Its length is about the same as the least depth of the tail, about 8 or 9 % of the length of the body or 40—43 % of the length of the head. The teeth are somewhat conical, in the lower jaw blunt, and in the upper jaw more pointed. They are set in a single row, which is often irregular, at intervals less than the breadth of a tooth. Their number on the blind side is $\frac{20-24}{20-23}$, on the eye side $\frac{8-11}{13-16}$. On the latter side they are set anteriorly, in the upper jaw for about $^1/_3$ of the length of the mouth, in the lower jaw for about $^2/_3$ or sometimes the whole of the length of the mouth, to a line with its inner corner. The branchiostegal membrane, as in all the Scandinavian Flatfishes except the Rough Dab (*Drepanopsetta*), is furnished with 6 larger rays on each side and 2 smaller ones at the middle. The 6 large rays are distant from the middle and only slightly flattened; but they are not always distinct or easy to count, this being due to the fact that the membrane does not lie flat, with the margin behind, as in other fishes, but is folded back, in this species and most of the others, to half the breadth of the membrane, which thus lies double[e].

The position of the fins is normal, and the rays are scaly in the ordinary manner. The dorsal fin begins on the blind side, just behind the perpendicular from the anterior margin of the pupil of the upper eye, and almost in a line with the nostrils of the blind side, and extends back to a point, the distance between which and the caudal fin is at least more than half the least depth of the tail, and sometimes only slightly less than that depth. The peduncle of the tail is thus longer than in either of the preceding species. The longest rays of the dorsal fin, the 34th, 35th and 36th from the beginning, are equal in length to the postorbital part of the head (about 12 % of the length of the body) or a little shorter. The anal fin resembles the dorsal fin, and terminates in the same manner, but begins just behind the perpendicular from the base of the pectoral fins, at a distance from the tip of the snout that measures 27—33 % (in youth about 26 %) of the length of the body. The anal spine is sharp and pointed. The caudal fin is rounded at the hind margin. It contains 12 or 13 branched rays, and 2 or 3 simple rays above and below, the innermost of the latter rays measuring $^2/_3$ of the length of the fin and the outermost $^1/_3$. The pectoral fin of the eye side measures $^2/_3$ of the length of the head or 12—14 % (in young specimens at least 10 %) of the length of the body. It usually contains 10 or 11 rays, the two (seldom three) uppermost simple, the others branched, and the third and fourth longest. In exceptional cases this fin contains 12 rays[a]. The pectoral fin of the blind side is visibly shorter, and generally contains 9—11 rays[b], the fifth and sixth being the longest. All the rays are often simple (at least during youth), and this is always the case with at least the uppermost 6 or 7 rays and the lowest ray of all. The ventral fins are still shorter than the left pectoral fin, their length being about 8 % (during youth about 6 %) of that of the body. They generally contain 6 simple rays, on the blind side sometimes only 5, but the penultimate and antepenultimate rays are sometimes imperfectly branched at the tip. The third or fourth ray is the longest.

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[a] Couch (*Hist. Fish. Brit. Isl.*, p. 185) mentions a specimen 33 cm. long, Day (Proc. Zool. Soc. London, 1885, p. 929) another 38 cm. long. Möbius and Heincke state that the species may attain a length of 40 cm.

[b] According to Sundevall and Day sometimes 4.

[c] According to Sundevall sometimes 22, according to Day sometimes 21.

[d] In specimens about 6 cm. long the longitudinal diameter of the eye is about 6 % of the length of the body or 27 % of the length of the head.

[e] It is probably this peculiarity that has given rise to the statement that the Flounders have 4 or 5 branchiostegal rays.

The number of rays is thus inconstant in all the fins. The following table shows how irregularly these variations appear:

Length of the body in millimetres.	*D.*	*A.*	*P.*	*V.*	*C.*
a) 282	69	52	11	6	3 + 12 + 3 = 18
b) 269	68	52	12|11	6	
c) 267	69	51	11	6	
d) 244	68	52	12|13	6	3 + 12 + 2 = 17
e) 243	68	53	10	6	18 (SUNDEVALL.)
f) 229	72	55	10	6|5	
g) 222	67	54	10|9	6	18 („)
h) 210	67	54	10	6	(„)
i) 210	76	59	10|9	6	18 („)
k) 133	80	61	11|10	6	18 („)
l) 94	75	55	11	6	18 („)
m) 57	71	59	10	6	
n) 34	74	—	—	—	18 („)

The rays of the dorsal fin may thus vary between 67 and 80[c] or to the extent of 14 rays, about $^1/_5$ of the minimum number; but we have no grounds for regarding these individuals as members of two distinct species. It is remarkable, however, that the maximum number of rays in this fin, as well as in the anal, apparently appears in the younger specimens[d].

The scales are fairly large and regularly arranged, being thus easy to count. In the lateral line they are deeply imbedded, and number about 80 or 90[e]. At the middle of the body there are about 30 scales in an oblique row from the lateral line to the back and 32 in the corresponding row to the anal fin. They are oblong and so narrow that they scarcely overlap each other at the sides, and the naked (outer) part is almost round. At the tip they are truncate, with between 8 and 13 (sometimes as many as 20) fine, pointed, uniserial spines. On the blind side the scales of the hind part of the body have fewer spines, and those of the front part none or only one or two. On the eye side the body is almost entirely covered with scales, large and imbricated, as usual, on the hind part; and only the nasal region and the snout, together with the lips and the greater part of the jaws, are scaleless, while small scales may be found on the blind part of the upper jaw and of the branches of the lower jaw. Most of the fin-rays, with the exception of the very first and last rays of the dorsal and anal fins, and the posterior rays of the pectoral and ventral fins, are each furnished with a row of scales. On the blind side, however, the operculum, preoperculum and interoperculum are for the most part naked, as well as the whole of the jaws, the snout, and the nasal region up to the beginning of the dorsal fin. Most of the fin-rays, too, on this side are without scales, with the exception of the caudal fin and the middle part of the dorsal and anal fins, where there is one row of scales on the inner (proximal) part of each of the rays. On this side the ctenoid scales of the body are set in patches along the dorsal and ventral margins and on each side of the lateral line.

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[a] This is the case with the two females sent to the Royal Museum from Wisby by Professor LINDSTRÖM.

[b] One of the above specimens from Gothland has 13 rays in the pectoral fin of the blind side.

[c] According to GOTTSCHE the minimum may be as low as 65.

[d] Also according to KROYER's table, l. c., p. 299.

[e] In different individuals we have found 79, 83, and 90 scales in the lateral line. The arched part of the line ends between the 24th and 27th scales

The coloration of the eye side is yellowish brown, with small, dark or brownish, sometimes reddish spots. It may be more or less dark, and fades after death, when the spots, too, grow indistinct. On the coast of Bohuslän, according to Mr. C. A. HANSSON[a], the following colour-varieties occur:

"α, the coloured side dark grayish brown, entirely undiversified;

β, the coloured side light brown, with more less numerous, small yellowish spots with a dash of red.

γ, the coloured side clay-gray, shading into brown and marked with small, more or less greenish spots.

"It is stated that variety α occurs on a hard, clayey bottom. β is the commonest, and occurs both on sandy and muddy bottoms, while γ, on the other hand, seems to keep to a sandy bottom. Intermediate forms are found, however, between all three varieties."

The changes of growth in this species may serve as an expression of those of the Flounders in general. The most important of them are given in the appended table:

Pleuronectes limanda.	From Bohuslän Most of the measurements given by SUNDEVALL.							From Råå (Scania)	From Cimbrishamn (Scania).		From Wisby.	
Sex						♂		♀	♀	♀	♀	♀
Length of the body to the end of the caudal fin in millimetres	34	57	61	94	133	223	243	229	267	282	244	269
Length of the head in % of the length of the body to the end of the caudal fin	23.9	21.9	20.5	22.3	21.8	19.7	19.0	20.7	21.9	20.9	21.1	20.8
,, ,, ,, ,, ,, ,, ,, base ,, ,,	28.6	27.1	24,5	26.3	26.4	24.1	23.0	25.2	26.6	25.8	25.4	25.5
Greatest depth of the body ,, ,, ,, end ,, ,,	30.8	30.7	31.1	34.6	33.9	37.6	38.7	38.4	38.2	41.5	41.8	40.9
,, ,, ,, ,, ,, ,, ,, base ,, ,,	37.5	36.0	37.2	40.0	41.0	46.1	48.0	46.8	46.4	51.2	50.3	50.0
Least ,, ,, ,, ,, ,, ,, end ,, ,,	8.8	9.1	8.2	8.6	9.0	8.0	8.4	8.3	8.0	8.3	8.8	9.0
Longitudinal diam. of the eyes ,, ,, ,, ,, ,,	6.0	6.1	—	5.3	5.3	—	4.1	4.8	5.4	5.1	5.0	4.9
Postorbital part of the head ,, ,, ,, ,, ,,	13.5	12.3	—	—	12.8	—	12.2	12.4	12.4	12.2	12.5	12.3
Length of the right pectoral fin ,, ,, ,, ,, ,,	—	9.1	—	11.9	11.2	13.4	12.3	13.5	13.4	13.3	13.7	13.0
,, ,, ,, ,, ventral ,, ,, ,, ,, ,,	—	7.0	6.5	6.5	6.4	7.1	7.7	7.8	8.0	8.0	8.6	7.0
,, ,, ,, ,, branch of the lower jaw ,, ,, ,, ,,		8.4		7.5	7.5	7.1	7.3	7.4	8.6	8.0	7.8	7.6
,, ,, ,, ,, ,, ,, ,, head		38.4		35.0	34.5	36.3	38.5	35.9	39.3	38.1	36.9	36.6
,, ,, ,, left ,, ,, ,, body to the end of the caudal fin	8.8	—	9.1	8.6	8.0	7.1	8.0	8.3	9.4	8.3	8.8	8.3
,, ,, ,, ,, ,, ,, ,, head	38.0	—	44.8	40.0	36.5	36.3	41.7	40.0	42.7	40.0	41.7	40.2
Distance between the anal fin and the tip of the snout in % of the length of the body to the end of the caudal fin	—	27.2	25.7	30.2	29.3	29.1	27.7	30.6	32.9	32.8	29.7	30.8
Length of the caudal fin ,, ,, ,, ,, ,,	16.4	17.2	16.4	18.4	17.3	18.4	17.6	17.9	17.6	18.9	17.0	18.2

Obs. With regard to the young specimens in this table SUNDEVALL observes: In the fourth (94 mm. in length) the teeth are in form and position like those of the largest specimen from Bohuslän. In the two smallest (34 and 57 mm. in length) the scales are apparently rather more rounded at the tip, and are furnished with fewer spines, than in the full-grown specimens. Their coloration is also fainter and more transparent, with more distinct spots, than that of the others; and they seem to belong to the fry of the previous year. Young specimens less than 25 mm. long are entirely transparent and colourless, with the exception of the eyes and the skeleton.

In spite of the fact that these measurements cannot be absolutely accurate, several of those in the first columns being derived from the observations of different persons, we may still draw from them the following rules, subject, it is true, to individual variations that are sometimes considerable. The relative length of the head decreases with age, the greatest depth of the body increases, while the least relative depth[b] remains almost the same, the relative size of the eyes diminishes, as well as the relative length of the postorbital part of the head, which in older specimens, however, is remarkably constant, but the length of the fins, on the other hand, undergoes even relative increase. The length of the right branch of the lower jaw shows a remarkable similarity to that of the ventral fin on the same side of the body, and the length of the left branch of the lower jaw to the least depth of the body.

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[a] By letter.

[b] According to KRØYER the least depth of the body is, as a rule, nearly 10 % of the length thereof, and thus greater than it is given in our measurements.

The length of the abdominal cavity occupies from $^{1}/_{7}$ to $^{1}/_{6}$ of that of the body; the secondary abdominal cavities extend, as usual, back to the posterior part of the base of the anal fin: we have found the termination of the ovary to lie, on the right side, in a line with the 18th—20th rays of the anal fin, counting from behind, and on the left side, in a line with the 26th ray. The short œsophagus and the stomach extend along the upper wall of the abdominal cavity, round the hind margin of the liver, to the middle of the hind wall of the abdominal cavity, where the pylorus is externally divided by a fold from the intestine, at the beginning of which lie three pyloric appendages. A little further along the intestine we find another, smaller appendage. The first coil of the intestine passes upwards, to the right, and enters the right secondary abdominal cavity for a short distance, scarcely half the length of the abdominal cavity proper. The second coil lies on the inner side of the first, but does not enter the secondary abdominal cavity.

The Dab occurs along the whole west coast of Scandinavia and at least from the Murman coast (Russia) to Iceland. It goes southwards to the Bay of Biscay, and penetrates the Baltic at least as far as Gothland. On the American side of the Atlantic it is represented by three very closely allied species[a], which to a certain extent combine the characters of the Dab with those of the preceding species, as well as of the following ones. A fourth species, which has been referred to the genus *Limanda*[b], inhabits the Pacific Ocean, and is distinguished from the Dab essentially by its larger head and longer pectoral fins alone. A fifth species, *Pleuronectes Vegæ*, which belongs to the same group — with the lower pharyngeals like branchial arches, and their teeth pointed and set in two rows — belongs to Japan, and is distinguished by the less marked curve of the lateral line and the extraordinary depth of the base of the caudal fin[c].

The Dab (Sw. *sandflundra* = Sand Flounder), as shown by its Swedish name, generally keeps to a sandy bottom and at a depth of 10 fathoms or more[d], but not unfrequently ascends into shallower water. Its food is composed of small crustaceans and other marine animals, such as worms, shellfish, starfish and sea-urchins. Sundevall found the stomach and the first coil of the intestine in one case crammed with small *Idotheidæ* (*Stenosoma*), together with pieces of Annelids and sprigs of small algæ (*Ceramium*, *Fucus*). In two females from the vicinity of Cimbrishamn the intestine is distended with a considerable quantity of mussels (*Mytilus edulis*), mostly whole and with the soft parts still undigested. The Dab thus swallows a great portion of its food without crushing it.

The spawning-season of the Dab occurs in spring and early summer, probably from the latter part of April to the month of June. The fry grow slowly. Day mentions some young specimens, 44 mm. in length, that were taken at the mouth of the Thames, in November, 1880. As the young specimens mentioned above, between 34 and 133 mm. long, were all taken by Fries in Bohuslän, on the 19th of May, 1838, Sundevall concludes that they cannot possibly belong to the fry of that year. "To all appearances," he says[e], "the smallest specimens were born in the previous summer, of the roe deposited at its beginning. The young specimen 94 mm. in length, which has a far more robust appearance and is of the same colour as the adult specimens, is evidently a year older, and I would regard it as being of exactly the same age as the larger specimen 133 mm. in length. Both these specimens seem to be in their third year. Hence it seems highly probable that this species requires four or five years to attain its ordinary size of from 20 to 25 cm."

In Bohuslän this species is called *sandskädda*, in Norway *sandflynder*, and in the Faroe Islands *sandflundra*.

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[a] *Pleuronectes* (*Limanda*) *ferrugineus* and *Pl.* (*Limanda*) *Beanii*, both with very short pectoral fins, the former also with numerous rays in the dorsal fin (*D.* 83—85) and the latter with uncommonly short head, its length, according to Brown-Goode, being only about 15 % of that of the body. The third species of this group — with the lower pharyngeals narrow, like branchial arches — on the east coast of N. America, *Pleuronectes* (*Pseudopleuronectes*) *americanus* has the elliptical shape of the Lemon Dab and the lateral line only slightly curved in front, and shows traces of the more or less tubercular ridge behind the eyes which is characteristic of the group of the Plaice.

[b] *Pleuronectes* (*Limanda*) *asper*, with few spines on the scales and with the length of the pectoral fin of the eye side about 16 % of that of the body.

[c] *D.* 69—72; *A.* 54—55. Least depth of the tail about $9^{1}/_{2}$—$11^{1}/_{2}$ % of the length of the body or 28—30 % of the greatest depth of the body.

[d] Lindström obtained specimens of this species that had been taken at a depth of 70 fthms., off Gothland. Brown-Goode's *Pleuronectes Beanii* was taken at a depth of 120—126 fthms., off Rhode Island.

[e] The same opinion recurs in Kroyer, l. c., pp. 314—315.

In Scania it is known as *slätta* (smooth, as it feels smooth when the hand is passed over it from the head to the tail) and *anglepiga* or *angerpiga* (Vang, Thin-girl), in Blekinge, according to Nilsson *slättika* (Smooth Flounder) or *fjällflundra* (Scaly Flounder), and in Gothland, according to Lindström, *glade* (*glatt* smooth). In *Svensk Zoologi* Qvensel and, after him, Svartz called the species *tunglik flundra* (Sole-like Flounder) or *dragskädda* (Handline Dab). In Denmark it is known as *slætte* (cf. *slätta*, above) and *ising*.

The Dab is taken together with other species in Flounder-nets and seines. It also takes a bait. Its flavour is considered tolerably good. It is best during late autumn and winter, before the spawning-season. In Duhamel's time[a], and probably long before then, the Dab had already won favour in France, and the inlanders preferred it to the Plaice, as it could be conveyed longer distances than other Flounders without losing its flavour. It also bears the process of drying and preserving like stock-fish better than the Plaice, says Duhamel. (Sundevall, Smitt.)

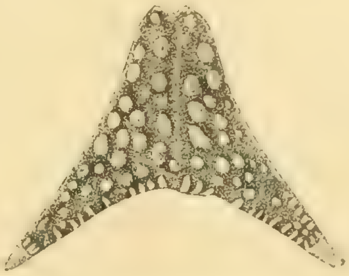

Fig. 108. Lower pharyngeals in *Pleuronectes flesus*, seen from above, and with the anterior end upward. Magn. 3 diam.

In Scandinavia as throughout the north-west of Europe, north of the Spanish Peninsula, the two following species are the commonest and, therefore, the best-known within the genus. They are remarkable, in the first place, for the unusually great variability of their characters, a circumstance which approximates them so closely to each other that Möbius and Heincke have declared, not without reason, that "it may appear on closer examination that these two species are links in a common form-series with the finest shades of distinction." Compared with the preceding species they have one common character in the larger size of the head in the majority of cases, a character which, as we have seen, generally belongs to juvenile forms. In addition to this juvenile character we find a greater prevalence in them than in the other species, of deviations from the generic character which fixes the right side as the eye side: sinistral and *double* individuals (coloured on both sides) are comparatively common in these species.

Throughout the Scandinavian fauna, to the best of our knowledge, we may rely upon the validity of the character, derived from the length of the head, by which the Dab is distinguished in the above scheme from the *platessa*-group[b]. But the above-mentioned Pacific form of the *limanda*-group apparently impairs the validity of this character, and we must, therefore, have recourse to an internal character. The first internal character that presents itself is the structure of the lower pharyngeals and their teeth. In all the Flounders of which we have already treated, the lower pharyngeals are narrow, and more or less resemble branchial arches, while their teeth are pointed. In the two following species and their nearest relatives these bones are broader and more or less triangular, and their inner margins are more or less contiguous at the middle of the floor of the pharynx. They are also furnished with obtuse, broad, molar teeth, sometimes arranged as closely as cobble-stones in a roadway (fig. 108). Another character may be derived from the structure of the skull — but in this respect we have examined only three species of the *Platessa*-group. Starting from the Pole (*Pl. cynoglossus*) we have seen the cranial part of the skull gradually grow longer and longer in proportion to the facial part thereof. This relation is shown above by a comparison between the length of the upper orbit and the total length of the skull. In the Pole and the Lemon Dab the length of the upper orbit measures about $^1/_2$, in the Common Dab only $^4/_9$, of the length of the skull from the tip of the head of the vomer to the occipital foramen. In adult examples of the following species, on the other hand, this proportion is only slightly more than $^1/_3$ (about 34 or 35 %). The natural relation between the preceding species and the following ones becomes clearer, however, after we have studied the latter.

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[a] *Traité des Pêches*, sect. IX, Chap. I, article V.

[b] The subgenus *Platessa* of some authors.

THE PLAICE (SW. RÖDSPOTTAN).

PLEURONECTES PLATESSA.

Plate XXI, fig. 2.

Body oval, its greatest depth in full-grown specimens varying between 38 and 42 % (sometimes as much as 45 %) of its length. Dorsal fin with at most about 75 (63—76[a]) rays, anal with at most about 55 (48—57[b]). Least depth of the tail as a rule less than 9 % (7—8$^1/_2$ %[c]) of the length of the body or about 33 % (30—35 %[d]) of the length of the head, which is more than 20 % (in full-grown specimens 21—24 %) of the length of the body. Distance between the anal fin and the tip of the snout usually less than 33 % (in adult specimens 28—32 %, but sometimes 34 %) of the length of the body. Anal spine behind the vent present. Rays of the ventral fins 6. Head without muciferous cavities. Lateral line only slightly curved in the abdominal region (above the pectoral fins). Vertebræ 43 or 44[e]. Jaw-teeth in adult specimens close-set, compressed incisors, on the eye side few, and generally smaller and more scattered than on the blind side; pharyngeal teeth obtuse molars; the triangular lower pharyngeals contiguous at the inner margin. Median frontal ridge between the eyes continued backwards by a raised bar, generally with five distinct protuberances. Scales as a rule cycloid. Coloration of the eye side grayish greenish-brown, with round, red or flame-yellow, brown-edged spots scattered on the body and also on the vertical fins.

R. br. 7; *D.* 63—76(77); *A.* (47)52—57(61); *P.* 10—12; *V.* 6; *C.* $x+13—16+x$; *Lin. lat.*, por. 80—90; *Vert.* 43—44.

Syn. *Platessa*, AUSON. (vide GESNER: *De Aquat.*, p. 675).

Pleuronectes oculis et tuberculis sex a dextra capitis, lateribus glabris, spina ad anum, ART., *Gen.*, p. 17; *Syn.*, p. 30; *Spec.*, p. 57; LIN., *Fn. Suec.*, ed. I, p. 113; *It. Wgot.*, p. 179; *Pleuronectes, Slätt-vahr*, LIN., *It. Scan.*, p. 326 et in indice VII.

Pleuronectes Platessa, LIN., *Syst. Nat.*, ed. X, tom. I, p. 269; RETZ., *Fn. Suec.*, LIN., p. 330; QVENS., Vet.-Akad. Handl. 1806, p. 211; NILSS., *Prodr. Ichth. Scand.*, p. 54; FABER, Tidskr. f. Naturv. Kbhvn, Bd. V, p. 245; ID., *Isis*, 1828, p. 865; SCHAGERSTR., Physiogr. Sällsk. Tidskr., p. 310; NILSS., *Scand. Fn.*, *Fisk.*, p. 612; EKSTR., v. WRIGHT, *Skand. Fisk.*, ed. 1, p. 219, tab. 60; GTHR, *Cat. Brit. Mus. Fish.*, vol. IV, p. 440; LINDSTR., Gotl. Läns Hush. Sällsk. Årsber. 1866, p. 26 (sep.); COLL., Vid. Selsk. Forh. Christ. 1874, Tillægsh., p. 144; MALM, *Gbgs, Boh. Fn.*, p. 525; WINTH,, Naturh. Tidskr. Kbhvn, ser. 3, vol. XII, p. 39; GIGL., Espos. intern. Pesc. Berl. 1880, Sez. Ital. Cat., p. 98; BENECKE, *Fische, Fischer., Fischz. West., O.-Preuss.*, p. 96; DAY, *Fish. Gt. Brit., Irel.*, vol. II, p. 25, tab. CI; MELA, *Vert. Fenn.*, p. 307, tab. IX; MÖB., HCKE, *Fisch. Osts.*, p. 91; LILLJ., *Sv., Norg. Fisk.*, vol. II, p. 358.

Pleuronectes quadrituberculatus, PALL., *Zoogr. Ross. As.*, tom. III, p. 423.

Platessa vulgaris, FLEM., *Brit. Anim.*, p. 198; GOTTSCHE, Wiegm. Arch. Naturg. Jahrg. 1, Bd. 2, p. 136; KR., *Danm. Fisk.*, vol. 2, p. 248; THOMPS., *Nat. Hist. Irel.*, vol. IV, p. 192; MOR., *Hist. Nat. Poiss. Fr.*, tom. III, p. 291.

Pleuronectes borealis, FABER, Isis 1828, p. 868; SCHAGERSTR., Physiogr. Sällsk. Tidskr., p. 310.

Pleuronectes Pallasii, STEIND., Stzber. Akad. Wiss. Wien, Math. Naturw. Cl., Bd. LXXX, Abth. I, p. 163.

The ordinary length of the Plaice on the west coast of Sweden is between 25 and 35 cm., though, even there, it often attains a larger size. Specimens more than 60 cm. long are, however, rare in Bohuslän. The length of the Plaice seems nowhere to exceed 80 cm. This size is sufficient, however, to render it the largest species of the genus.

The body is oval and, in youth especially, rather elongated, the greatest depth, excluding the fins, varying in young specimens (less than 2 dm. long) between 44 and 49 % of the length to the base of the caudal fin, and in older specimens between 50 and 57 % of the latter measurement. The thickness is somewhat less than $^1/_5$ of the depth. Both in the depth and thickness, however, there are many individual variations. In this species too, we often find that when a specimen has exceeded the ordinary size of the species, it reverts, by a kind of reaction, to the juvenile form.

The relative length of the head decreases with age, and varies, subject to the same remark with regard to individual variations, in young specimens between 31$^1/_2$ and 28 % of the length from the tip of the snout to the base of the caudal fin, and in older specimens between

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[a] According to GOTTSCHE 61—77: the latter number is also given by ARTEDI.

[b] Sometimes 47, according to KRØYER; sometimes 61, according to GOTTSCHE.

[c] Exceptionally 9.

[d] Exceptionally 40.

[e] The latter number in two of the skeletons in the possession of the Royal Museum.

28 and 26 %, sometimes as low as $25^1/_2$ %, of the same measurement. The form of the head is wedge-shaped, with the snout rather tumid and with a deep depression in the dorsal edge at the upper eye. The chief characteristic of the species consists in the row of osseous protuberances, usually 6 in number and of different sizes, that extends forward from the beginning of the lateral line of the body to the eyes. Here they are replaced by a raised, smooth, bony keel, which bends down between the eyes, forming a dividing ridge between them, and anteriorly divides into an angle that includes the posterior part of the nasal cavity of the eye side, and ends in front of each eye in a more or less distinct knob, most developed in front of the upper corner of the lower eye. The first-mentioned protuberances do not all belong to the head itself. The penultimate one, which is generally the largest, is situated on the pterotic part of the temporal bone of the skull (*os squamosum vel pteroticum*), but the last of all belongs to the posttemporal bone (the suspensory bone of the shoulder-girdle). The mouth is of about the same size as in the last species, but the lips are more tumid. The lower jaw is somewhat prominent, the length of the branch of the lower jaw on the blind side varying between about 33 and 40 % of the length of the head, or during youth between about 10 and 9 %, and in older specimens about 8 %, of the length of the body[a]. The teeth are small, in young specimens sharp and set in two rows (at least in the blind side of the lower jaw), but in adult specimens bluntly pointed, close-set incisors, set in a single row in both jaws. Their number varies in different individuals, both in the upper and the lower jaws. In the upper jaw, on the intermaxillary bone of the blind side, we may find from 19 to 36[b] teeth, and on the intermaxillary bone of the eye side, from 3 to 14[b]. In the lower jaw the branch on the blind side is furnished with from 20 to 45[b] teeth, and that on the eye side with from 5 to 14[b]. In front, in the middle of the jaws, there is a distinct space between the teeth of either side. The pharyngeals, 6 above and 2 below, are armed with broad, convex teeth, set in rows. The gill-rakers are scarcely of average size, and are also scattered, there being 11 or 10, sometimes only 7, on the first branchial arch. The nostrils are situated as in the preceding species, those of the blind side lying in the middle of the deep depression of the dorsal edge at the upper eye. But the anterior nostril of the eye side is long and perfectly tubular, while that of the blind side is more distinctly cut in an oblique direction. The posterior nostrils are like slits, in most cases with the margin more or less raised in a tubular form. At the margin of the tubes formed by the anterior nostrils we find, in front, a small, pointed, dermal flap, which is more distinct, however, in the following species. The tongue is narrow and pointed, as is generally the case in this genus, and without teeth. The gill-openings are middle-sized, and are furnished with 7 branchiostegal rays. The eyes are generally set on the right side, seldom on the left, their longitudinal diameter, in specimens of average size (33—34 cm. long), being about $^1/_5$ (18—21 %) of the length of the head; and the lower eye is only slightly in front of the upper.

The body is covered, as a rule, with cycloid scales alone, which are thin and deeply embedded, contiguous but not imbricated. The scaly covering extends forward to the eyes and along the cheek below the lower eye, to the articulation of the under jaw; but on the blind side the operculum and the greater portion of the preoperculum are naked. Imbricated scales occur on the eye side of the larger rays in the dorsal and anal fins[c] and on both sides of the caudal fin. The pectoral and ventral fins of the eye side are also partly covered with scales, but only at the base. There is one variety, however, GOTTSCHE's *Platessa Pseudoflesus* (l. c., p. 143) and NILSSON's *varietas baltica*, commonest in the Sound and the south of the Baltic[d], and known at Abekås as *horunge* (bastard), "because it is believed to be a hybrid between the Plaice and the Flounder," which is distinguished by ciliated scales, as a rule only on the eye side, which are imbricated even on the body, and are most distinct along the lateral line and the bases of the dorsal and anal fins, and on the head.

The course of the lateral line, which is slightly arcuate above the pectoral fins, is straight from this point, and fairly closely follows the middle of the sides, out over the caudal fin. The occipital branch (supratemporal, TRAQUAIR) runs, as usual, upward and forward towards the beginning of the dorsal fin, and is simple in the great majority of cases, but sometimes (fig. 106) divides superiorly and sends out a small branch (*sptr*) in a backward direction. Here we have a trace of resemblance to the North American forms, which are distinguished by a more developed dorsal branch of the system of the lateral line.

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[a] In very large specimens there is sometimes a reversion to the juvenile form.

[b] The latter number in a female 65 cm. long. In this case the dentition-formula was: $\frac{14—36}{14—45}$.

[c] Very often, however, these scales are wanting.

[d] KROYER found this variety off Hästholm as well

The dorsal fin begins on the blind side, as in the preceding species, but a little further forward, the first ray being inserted, in normal specimens, somewhat to the left of the posterior nostril of the blind side and in a line with the anterior margin of the pupil of the upper eye. It ends at a distance from the caudal fin about equal to $^1/_3$ of the postorbital length of the head, and its base occupies as a rule about 84—86 % (sometimes as much as 88 %) of the length of the body to the base of the caudal fin. Its greatest height, situated generally between the 30th and 40th rays from the beginning (on an average at the 36th), is about 12—15 % (on an average 14 % and sometimes nearly 16 %) of the length of the body *minus* the caudal fin. All the rays are simple. The anal fin, which is of the same shape as the dorsal, begins below the insertion of the pectoral fins, at a distance from the tip of the snout that only seldom[a] attains or exceeds 40 % of the length of the body to the base of the caudal fin. Its greatest height, situated on an average at about the 20th ray from the beginning, is generally about the same as that of the dorsal fin, and the length of its base is never less than 60 % (sometimes as much as 68 %) of the length of the body *minus* the caudal fin. The pectoral fins, which are inserted just below the hind point of the operculum, are rather obtuse and oval, and contain 10—12 rays on the eye side, 9—11 on the blind side. On the eye side the uppermost 2—4 rays and the lowest one or two are simple, which is generally the case with all the rays, or at least most of them, the middle ones excepted, on the blind side. The other rays are branched. The first ray is not half so long as the second, and the third or fourth ray is the longest. The ordinary length of the pectoral fin of the eye side in the males is between 13 and 15 % of the length of the body *minus* the caudal fin, in the females between 10 and 12 % thereof: on the blind side this proportion is about 11 % in the males and about 9 % in the females. The ventral fins are more pointed, almost equal in size, and fairly alike in both sexes. They contain 6 simple rays, and their length is about 10 or 11 % (sometimes 8 or 12 %) of the length of the body to the base of the caudal fin. The caudal fin, the median length of which varies between 20 and $26^1/_2$ % of that of the rest of the body, is obtusely rounded and generally contains 14 branched rays[b], and 3 simple supporting rays above and below. The vent lies a little to the blind side. The spine at the beginning of the anal fin may sometimes be hidden, especially in large specimens, by the skin.

The internal organs are in all essential points the same as those of the preceding species. The length of the abdominal cavity is $^1/_6$ or $^1/_7$ of that of the body. At the boundary between the stomach and the intestine, at the upper part of the hind wall of the abdominal cavity, we generally find 2 or 3 short pyloric appendages, and further down the intestine is furnished with another similar, but somewhat shorter appendage. The intestine forms only 2 coils, the one within the other, and enters only a short distance into the secondary abdominal cavity of the eye side. Both the secondary abdominal cavities seem, however, to attain the same length as in the preceding species. In the males they are, as usual, but little developed.

The coloration, with the red spots, which are half the size of the eyes or somewhat larger, but have a dark or sometimes light border, which renders them as large as the eyes or even larger, is olive-brown or chestnut, but varies as in all the Flounders, being lighter in young specimens — in very young ones light gray, resembling the colour of sand or gravel — and in old specimens usually darker. The arrangement of the spots seems generally to be irregular; but in most cases they lie in longitudinal rows. At least one of these rows runs parallel to the dorsal fin and one to the anal, at their bases, and in young specimens there are five or six spots in the row along the base of the dorsal fin, and four or five along that of the anal. The blind side is white, but in large specimens generally marked with scattered, red or brown spots. The tips of the rays in the dorsal and anal fins are also white; and the pectoral and ventral fins are without spots. The iris is silvery white, with a narrow brassy ring round the dark blue pupil; but this ring usually vanishes some time after the death of the fish.

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[a] To the best of our knowledge only in young and very large (overgrown) specimens. As a rule this distance measures 34—38 % of the length mentioned.

[b] Sometimes 13, seldom 12 or even 16.

Reversed specimens of the Plaice, as of the other Flatfishes, occur sometimes, though not very often, with the eyes and the colour on the left side. We may also meet with double specimens, with both sides coloured and sometimes with the characteristic row of bony protuberances repeated on the blind side of the head, or albinos, entirely or partly white or golden like Goldfish, but with handsome orange spots (Möbius and Heincke)[a].

The Plaice occurs along the whole west coast of Europe, from the extreme north down to the south of France. As appears too, from the list of synonyms, we can find no specific difference between the Plaice and the form from Alaska and Kamchatka described by Pallas under the name of *Pleuronectes quadrituberculatus* and by Steindachner under that of *Pleuronectes Pallasii*. A young Plaice from the White Sea (fig. 109) corresponds, as far as we can judge, exactly to this form, with the only exception that in Steindachner's figure, and also in a specimen taken by the Vega Expedition in Port Clarence, the body is narrower behind. Thus, the Plaice seems also to occur in the basin of the Pacific. South of France we have no recorded instance of its occurrence in the Atlantic[b]; but according to Giglioli, Professor Trois found two specimens in the fish-market of Venice, a circumstance which apparently shows its occurrence in the Adriatic. It also enters the Baltic. We have learnt from the lips of Baron G. C. Cederström that it is caught sometimes, though extremely seldom, in the seine, off Ingarö in the island-belt of Stockholm. According to Lindström (l. c.) it is occasionally taken in summer on the coast of Gothland. According to Seidlitz[c] it is included by Kawall among the fishes of Courland; but the statement is considered doubtful, as well as Fischer's account of its occurrence in the Gulf of Finland. In the south and west of the Baltic it is not uncommon, and still less so in the Sound and the Cattegat. "Nowhere in Danish waters within the Skaw is the Plaice entirely wanting," says Winther, "but there is a considerable difference in the frequency of its occurrence at different spots, owing to certain peculiarities in its manner of life. It spawns at the end of winter or early in spring, at a depth of three or four fathoms. During summer the Plaice retire slowly from the spawning-places to deeper water, and during the greater part of the year they remain at a depth of 15 or 16 fathoms, where they pass the winter. If a piece of water does not possess sufficiently wide stretches of this depth, but only contains small holes or consists chiefly of patches of shallower water, here and in the adjoining shallows the Plaice is always of rare occurrence, as for example in the extensive reach of water along the north coast of Fünen."

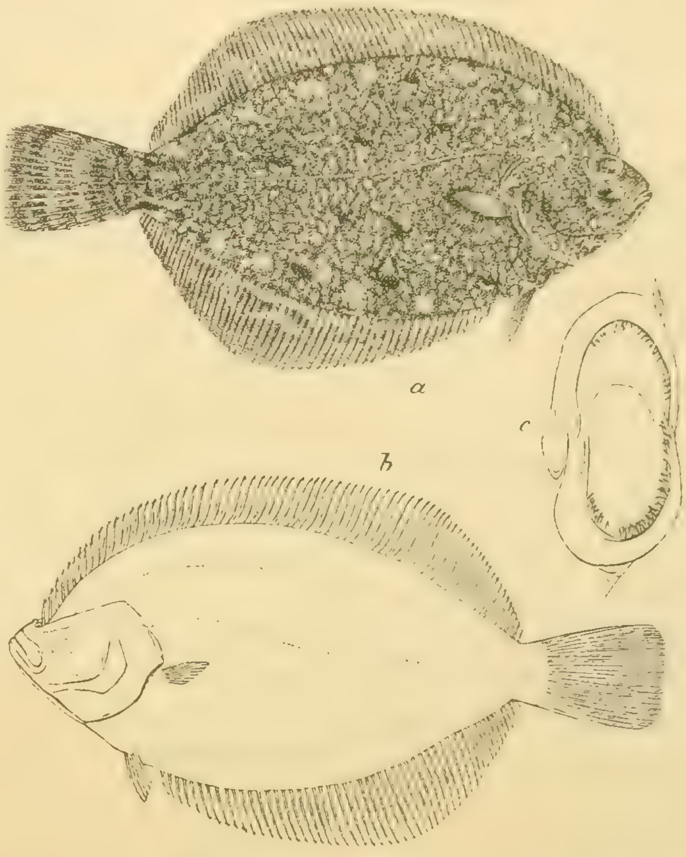

Fig. 109. Young Plaice from Archangel, forwarded to the Royal Museum by Lieut. H. Sandeberg (= *Pleuronectes quadrituberculatus*, Pallas; *Pleur. Giersii*, Sandeberg). *a* and *b*, natural size; *c*, the mouth, opened and magn. about 6 diam., to show the pointed jaw-teeth of young specimens.

In the Cattegat the Plaice is fairly common. Off Anholt, between February and August, 1885, 45,456 kgrm. of Plaice were taken by the fishermen from Hornbæk (Zealand) alone[d]. The entire catch of the

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[a] A specimen of this variety, lemon-yellow, clouded with a darker colour at the middle of the body and on the eye side of the jaws, was caught on the west coast of Jutland in February, 1890, and sent to the Royal Museum by Mr. O. Fredericksen of Copenhagen.

[b] Benecke (*Handbuch d. Fischz. u. Fischer*, Max v. d. Borne — p. 113) states, though without giving any authority for his statement, that the Plaice occurs as far south as the coast of Portugal.

[c] *Fauna baltica*, p. 118.

[d] Dansk Fiskeriselskabs Medlemsblad, 1886, p. 24.

Danish Plaice fishery within the Skaw, during the year 1885, was valued at 836,881 crowns (£46,493)[a]. According to v. Yhlen[b] about 2 million Plaice, of a value of 133,000 crowns (£7,390), were taken in 1879 off the coast of Bohuslän. At the Skaw large quantities of Plaice are taken and conveyed thence to Gothenburg, where they are, therefore, known as *skarskäddor* or *skaboskäddor*. According to A. W. Malm the Plaice is "common along the coast of Bohuslän, where it generally keeps to a bottom of firm sand, at a depth of 10—14 fthms., and prefers spots close in shore or at the edge of the *gutters* between islands and islets, where there is usually a strong current in some direction or other." The larger specimens, which are found even in the Sound, are known by the Danish fishermen as *præsteflyndre* (Priest-flounders, i. e. fit for a priest's table) or *hansinger*. Many of them are now sent, together with Plaice of ordinary size, by rail to Stockholm, where they are known in the market as *kungsflundror* (King's Flounders). Faber regarded these King's Flounders as a distinct species (*Pleuronectes borealis*), while Gottsche took them to be a special variety of the Plaice. The *King's Flounder* is said to be distinguished by the light ring round the red spots, most distinct on the dorsal and anal fins, the usually hidden anal spine, and a number of characters which we have noticed above as retrogressions to the juvenile type. But the irregularity in the appearance of these characters, the transitions to the common Plaice, and finally the fact that no young King's Flounders have ever been found, induced both Nilsson and Krøyer to declare that the King's Flounder is nothing more than an old, overgrown stage of this species.

In the North Sea the Plaice is — or at least has been — still more common and still more remunerative to the fisherman than in the Cattegat and Skager Rack. An important fishery for this species is also pursued in the English Channel and the Irish Sea. After the great strides that the trawl-fishery has made in later years, complaints may be heard in most places that the Plaice, like other Flatfishes, has become considerably rarer; but as recently as 1888 the statistical reports show[c] that during this year Plaice were imported into England and Wales to a value of £614,585. On the coast of Iceland the Plaice is also found and seems to be by no means rare; but it is unknown in Greenland and on the east coast of North America.

For the purposes of the table the Plaice is regarded as one of the best of the Flatfishes. It comes next to the Sole and the Turbot, or, in the opinion of many, a little lower, next to the Halibut; and its abundance places it within the reach even of the poor. In London especially it is consumed in large quantities[d]; but in other large towns as well, Copenhagen and Hamburg for example, it is one of the most important fishes in the market. Its flesh is white and firm, and is best when fried. During the spawning-season — winter and spring[e] — its flesh is rather flabby; but, as great numbers of Plaice spawn at different times, specimens fit for table may be procured even during this period.

Like the rest of the Flatfishes the Plaice generally leads a sluggish life, hidden in the sand, where it speedily covers itself with a few strokes of its fins, so completely that only the head or even only the snout and the mobile eyes are in sight. However, it is not at all destitute of the power of motion, and at need is one of the swiftest of fishes. "In October, 1869," says Buckland[f], "I witnessed the drawing of a seine net opposite our oyster fishery at Reculvers, near Herne Bay, Kent, when a considerable number of plaice were caught; but just as the net arrived at the edge of the waves it "rolled," and nearly all the plaice escaped. A fisherman cried, "Look out, they'll sand!" a capital expression, for I found that the fish sunk into the sand with such rapidity that the operation must be seen to be believed. The plaice lifts up its head and the upper third of its body and then brings it down on the sand three or four times with sharp, quick raps; a small cavity is thus made in the soft, wet sand, which at once fills with water; the fish then works its fins on each side of its body with such a rapid motion that they seem almost to vibrate. These combined efforts enable the fish to conceal itself almost quicker than the eye can follow, and nothing can be seen but its eye, which is of a lovely emerald colour." The Plaice is also capable of making speedy migrations; and it is well known that a fishing-ground may one day afford an abundant catch, and the next be entirely unproductive. Brehm[a] also quotes the perhaps exaggerated statement of a captain who said that for a whole day he had watched the Plaice swimming one after another over a sandbank, in a shoal so dense that not a glimpse of the bottom could be seen, though the water was clear and transparent.

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[a] Ibid., p. 82.

[b] *Not. üb. die Schwed. Fischereien*, Supplement to the Catalogue of the Swedish Department, Fisheries Exhibition Berlin, 1880.

[c] *Fish. Trades Gazette*, vol. VI, No. 295 (12th Jan., 1889), p. 8. The catch of Plaice in Scotland and Ireland is not included here. It is summed up in the tables with the catch of other fishes.

[d] Cf. Holdsworth, *Deep Sea Fishing*, p. 17.

[e] Among some Plaice from Gothenburg that were purchased here in Stockholm at the beginning of May, 1889, some had not yet begun to spawn and were of excellent flavour, while others were new-run and hardly fit to eat.

[f] *Nat. Hist. Brit. Fishes*, p. 180.

The Plaice also inhabits fresh water. Krøyer found it[b], though the specimens were only small, in Gaarby Lake, at the extreme north of Jutland; and Feddersen[c] assigns it to the Laastrup, a stream that falls into Liim Fjord. Blanchère also states[d] that it freely ascends the French rivers which have a sandy bottom, as the Loire, Garonne, Dordogne etc. In the Dordogne it is even said to deposit its spawn.

The Plaice feeds on all those marine animals which, like itself, prefer a sandy bottom, small fishes, chiefly Sand-eels (*Ammodytes*), and lower organisms, principally mussels, the shells of which it crushes with its pharyngeal teeth. In most cases the anterior part of the intestine is crammed with bits of mussel-shells. Annelids, crustaceans, and Echinoderms (sea-urchins and starfish) also form an important part of its diet.

In Bohuslän the spawning-season of the Plaice begins in early spring, in April according to Ekström, or even in February according to Malm[e]. Krøyer observes that even in December he has found the ovaries well-developed, and during mild winters has met with breeding Plaice even in January. In a female nearly $2^{1}/_{4}$ kgrm. in weight Buckland[f] found the ovaries to weigh nearly $^{1}/_{8}$ of the weight of the fish, and he estimated the number of the eggs at 144,600. Hensen arrived at the following results[g]:

Plaice.

Length of the body.	Weight of the body.	Weight of the ovaries.	Number of the eggs.
48 cm	1,050 gr.	66.0 gr.	300,000
36 „	457 „	132.5 „	80,940
31 „	374 „	113.4 „	111,300

The average size of the ripe eggs of the Plaice, according to the latter writer, is 1·7—1·8 mm. They are then transparent, colourless and without oil-globules. In salt water they float, but in brackish water they sink to the bottom. The newly-hatched fry, according to Hensen, are about 5·26 mm. long, with pigmented eyes, a large vitelline sac, and the vent close to the latter. According to observations made by Möbius and Heincke in an aquarium the transference of the eye in the young specimens is completed in four weeks. During the summer they are met with in inlets and at shallow spots with a sandy bottom. At the end of July, according to Krøyer, the fry are about 3 in. long; and Fries forwarded to the Royal Museum young Plaice between 70 and 83 mm. long, which had been taken in Bohuslän in July, 1835. It seems doubtful, however, whether these latter specimens belonged to the fry of that year[h]. As late as the end of September, Sandeberg's Expedition of 1877 obtained young Plaice, between 29 and 43 mm. long, off Waideguba to the extreme west of Kola Peninsula, that had not yet acquired the characteristic row of protuberances behind the eyes. Fry of this size are distinguished by the gray colour of the body, densely mottled with dark brown and red spots, a colour which they still retain at a length of 70—80 mm., when the row of protuberances has already appeared. The most trustworthy character, to distinguish them from the fry of the following species, consists in the number of the fin rays, the somewhat deeper form of the body, and the shorter peduncle of the tail. The length of the base of the anal fin — more than half that of the body —

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[a] *Thierleben*, Bd. 8, p. 192.

[b] Tidskrift for Fiskeri, 1:ste Aarg., p. 44.

[c] Naturhist. Tidskr. Kbhvn, ser. 3, vol. XII, p. 76.

[d] *Nouv. Dict. Gén. des Pêches*, p. 636.

[e] As we have remarked above, some of the Bohuslän Plaice purchased in Stockholm in 1889 were evidently ready to spawn at the beginning of March.

[f] *Nat. Hist. Brit. Fish.*, p. 180.

[g] Vierter Ber. Comm. Wiss. Unters. Deutsch. Meere (1877—1881), p. 306.

[h] Cf. the remarks on the growth of the preceding species.

to the best of our knowledge is also a trustworthy character.

In the North Sea the Plaice is taken chiefly in the trawl, a huge pocket-net kept open at the top of the mouth by a bar between 10 and 15 m. long, which has a heavy frame of iron (the trawl-head) at each end, and at the bottom fastened along a thick rope (the ground-rope) which trails along the bottom. In Scandinavian waters it is generally taken in large-meshed nets, known as Flounder-nets. In Norway, at suitable spots, it is also speared, according to LILLJEBORG. In the sea it seldom takes a bait; but in the French rivers, according to BLANCHÈRE, the Plaice is taken with hook and line, worms being used as bait.

In Bohuslän the species is known as *Rödspotta* (Red-spot). In the south of Sweden it bears the more Danish name of *Rödspätta* or simply *Spätta*, or is sometimes called *Skålla* (cf. its German name *Scholle*). At Kullen it is also known as *Slätta* (Smooth); and QVENSEL (l. c.) and EKSTRÖM[a] state that in Bohuslän it is also called *Mareskädda* or *Marieskädda*.

(EKSTRÖM, SMITT.)

THE FLOUNDER (SW. SKRUBBSKÄDDAN).

PLEURONECTES FLESUS.

Plate XXI, fig. 1.

Body oval, the greatest depth in full-grown specimens varying between 38 and 43 % (sometimes 44 %) of the length. Dorsal fin with at most about 60 (53—62) rays, anal with at most about 40 (37—42[b]). Least depth of the tail usually less than 8 % (6·8—8·2 %) of the length of the body, or about 32 % (28—36 %) of the length of the head, which is more than 22 % (in adult specimens $22^1/_2$—$25^1/_2$ %) of the length of the body. Distance between the anal fin and the tip of the snout as a rule more than 34 % (in adult specimens 34—39 %, but sometimes 33·3 %) of the length of the body. Postabdominal bone ending in an anal spine projecting forward. Rays of the ventral fins 6. Head without muciferous cavities. Lateral line only slightly curved in the abdominal region. Vertebræ 35—37. Jaw-teeth, pharyngeals and pharyngeal teeth like those of the preceding species. The frontal wall between the eyes continued backwards by a (more or less distinct) raised bar, rough with a number of small tubercles and at the extreme end (above the operculum) somewhat widened. Scales of the body partly cycloid, but usually for the most part changed into spinous warts, the largest of which are set in a row on the margin of the body, along the bases of the dorsal and anal fins, there being one spinous wart on each side of these fins in the interval between each ray and the next one to it. Coloration of the eye side grayish brown with darker, cloudy spots and irregular stripes, and also round, red or yellow, not ocellated, often indistinct, small spots; ground-colour sometimes blackish blue.

R. br. 7; *D.* 53—62[c]; *A.* 37—42[d]; *P.* 9[e]—11; *V.* 6; *C.* $x + 12 + x$; *L. lat.* por. 72—85 (+ 24 ad 29 in pinn. caud.); *Vert.* 35—37.

Syn. *Le Flez*, BELON, *La nature et diversité des poissons*, p. 141.

Pleuronectes oculis a dextris, linea laterali aspera, spinulis supine ad radices pinnarum, dentibus obtusis, ART., *Gen.* p. 17; *Syn.*, p. 31; Spec., p. 59.

(?) *Pleuronectes* oculis a sinistra, linea laterali utrinque aculeata. ART., *Gen.*, p. 18; *Syn.*, p. 32; ex WILLUGHBY, *Hist. Pisc.*, p. 93 (*Rhombus aculeatus*, RONDEL.) *D.* 66, *A.* 50 (vix *flesus*); hinc vero *Pleuronectes passer*, LIN., *Syst. Nat.*, ed. X, p. 271.

Pleuronectes, *Skrobba*, LIN., *It. Scan.*, p. 326 et in indice VII.

Pleuronectes flesus, LIN., *Syst. Nat.*, ed. X, tom. I, p. 270; *Fn. Suec.*, ed. II, p. 116: RETZ., *Fn. Suec. Lin.*, p. 331; QVENS., Vet.-Akad. Handl. 1806, p. 214; SWARTZ, *Sv. Zool.*, Bd. 2, No. 46; HOLLB., *Beskr. Boh. Fisk.*, Gbgs Vet., Vitt. Samh. N. Handl., IV, p. 38; NILSS., *Prodr. Ichth. Scand.*, p. 55; EKSTR., Vet.-Akad. Handl. 1834, p. 53; GOTTSCHE (*Platessa*), Arch. f. Naturg. I (1835), Bd. 2, p. 146; KR., *Danm. Fisk.*, Bd. 2, p. 276; LILLJ., Vet.-Akad. Handl. 1850, p. 306; NILSS. (*Pleuronectes*), *Skand. Fn.*, *Fisk.* p. 618; EKSTR., v. WR., *Skand. Fisk.*, ed. 1, p. 215, tab. 55; GTHR, *Brit. Mus. Cat.*, *Fish.*, vol. IV, p. 450; SIEB. (*Platessa*), *Süsswasserf. Mitteleur.*, p. 77; MGRN, *Finl. Fisk.* (disp.

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[a] Gbgs Vet., Vitt. Samh. Handl., Ny tidsföljd, 1 häft., p. 39.

[b] Sometimes 45, according to GOTTSCHE.

[c] Sometimes 63, according to STEINDACHNER.

[d] STEINDACHNER gives, as rare exceptions, however, 46—48 rays in the anal fin. So large a number has never been found in the northern *Pl. flesus*, but probably occurs in a Mediterranean variety, BONAPARTE's and CANESTRINI's *Pl. passer*.

[e] Sometimes 8; according to KROYER.

Helsingf.), p. 24; Blanchard (*Pleuronectes*), *Poiss. d. eaux douces Fr.*, p. 267; Lindstr., *Gotl. Fisk.* (Gotl. Läns Hush. Sällsk. Arsber. 1866), p. 22 (sep.); Steind., Stzber. Akad. Wiss. Wien, Math.. Naturw. Cl. LVII (1868), I, p. 719; Coll., Vid. Selsk. Forh. Christ. 1874, Tillægsh., p. 146; ibid. 1879, No. 1, p. 82; Malm, *Gbgs*, *Boh. Fn.*, p. 530; Winth., Naturh. Tidskr. Kbhvn, ser. 3, vol. XII, p. 41; Fedders., ibid., p. 76; Mela, *Vert. Fenn.*, p. 306, tab. IX; Day, *Fish. Gt. Brit.*, *Irel.*, vol. II, p. 33, tab. CV; Möb., Hcke, *Fisch. Osts.*, p. 95; Lillj., *Sv.*, *Norg. Fisk.*, vol. II, p. 376; Mela, Sundm., *Finl. Fisk.*, pl. XXIII.

Pleuronectes passer, Bl., *Naturg. Fisch. Deutschl.*, II, p. 57, tab. 50; Retz, *Fn. Suec. Lin.*, p. 333; Qvens., Vet.-Akad. Handl. 1806, p. 218; Hollb., *Beskr. Boh. Fisk.*, l. c., p. 48; *var.* (*A.* 46—48): Bonap. (*Platessa*), *Fn. Ital.*, III, *Pesci*, tav. No. 98, fig. 1; Canestrini, *Arch. p. l. Zool. ecc.*, vol. I, fasc. I, p. 8, tab. I, fig. 1; Mor. (*Flesus*), *Hist. Nat. Poiss. Fr.*, tom. III, p. 301; *Pl. italicus*, Gthr, *Cat.*, l. c., p. 452.

Pleuronectes stellatus, Pall., Nov. Act. Petrop., I, p. 347, tab. 9, fig. 1, *Zoogr. Rosso-Asiat.*, tom. III, p. 416; Rich., *Fn. Bor. Am.*, *Fish.*, p. 257; (*Platessa*) *Zool. Voy. Herald*, p. 164, tab. XXXII, fig. 1—3; Gthr (*Pleuronectes*), *Cat.*, l. c., p. 443; Jord., Gilb., Bull. U. S. Nat. Mus., No. 16, p. 835; Br.-Goode, *Fisher.*, *Fish.-Industr. U. S.*, p. 184 (Jordan), tab. 46 (Todd). — Striato pinnatus (Tiles.), pinn. dors. et anal. sat altis, pinn. pect. sat longis, spatio interoculari plerumque sat magno. Varietas forsan, vix species distincta.

Pleuronectes luscus, Pall., *Zoogr. Ross. As.*, tom. III, p. 427 (adn. *A.* 46); Nordm. (*Platessa*), *Voy. Russ. Merid.*, Demid., vol. 3, p. 532, tab, 27 et 28.

Flesus vulgaris, Mor., l. c., p. 299.

Pleuronectes Bogdanovii, Sandeberg, Bull. Soc. Natur. Moscou, LIII (1878), No. 3, p. 236.

The usual length of the Flounder in Scandinavian waters is about 20—25 cm., though it sometimes rises as high as about 37 cm.[a] In other waters it seems to attain a much greater size[b]. The greatest depth, between the fins, is about half the length from the tip of the snout to the base of the caudal fin[c]. The least depth, that of the peduncle of the tail, is between about $^{1}/_{10}$ and $^{1}/_{12}$ of the same length. Greatest breadth (thickness) $^{1}/_{5}$ of the depth. The head is compressed and heart-shaped, its length being 27—31 % (on an average $28^{1}/_{2}$—$29^{1}/_{2}$ %) of the length of the body to the base of the caudal fin. The row of protuberances on the head which is so characteristic of the preceding species, is not unrepresented here. In this species too, we find a raised, bony ridge, at the same spot and with the same curve back from the eyes, behind somewhat widened and interrupted above the gill-cover, and continued by a rough or smooth knob on the post-temporal bone. Here, however, the surface of the bony ridge is not broken up into distinct, separate protuberances, but is only rough with small tubercles or sometimes for the most part smooth. In this species too, the mouth is of moderate size, with tumid lips. The lower jaw projects slightly beyond the upper; and the length of the branch of the lower jaw on the eye side varies between about 33 and 38 % of the length of the head or between about 9 and $7^{1}/_{2}$ % of that of the body. The jaw-teeth resemble those of the preceding species; but even in adult specimens of this species we have sometimes found them set in two rows on the blind side, both in the lower jaw and on the intermaxillary bone. It is also very common — most common, it would appear, in the south — that the pointed form which the jaw-teeth possess during youth, is to a certain extent persistent in adult specimens, the jaw-teeth then being bluntly pointed, less distinctly chisel-shaped, and separated from each other at the tip. In the upper jaw we have counted 14—25 teeth on the intermaxillary bone of the blind side, and 8—12 on that of the eye side. In the lower jaw these specimens had 14—26[d] teeth on the blind side and 11—16 on the eye side. The pharyngeal apparatus is essentially the same as in the preceding species. In the roof of the pharynx we find on each side an oblong, roundish, fleshy swelling, armed with several transverse rows of blunt teeth. The osseous framework of this swelling is formed by the three upper pharyngeals, which are each furnished with two (according to Kroyer sometimes as many as four) rows of teeth. The lower pharyngeals (fig. 108, page 391 above) are broader than in the preceding species and more abundantly furnished with teeth, which in several irregular rows almost entirely fill the upper surface of the bones. The hindmost of these teeth, a row on the posterior, concave margin of the triangle, are much more like the jaw-teeth in shape, being bluntly pointed, cylindrical, and curved somewhat forward. The number of gill-rakers on the first branchial arch varies between 12 and 16.

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[a] Möbius and Heincke say 50 cm. On the French coast, according to Moreau, the species sometimes attains a length of 45 cm.

[b] *Pleuronectes stellatus*, in which we have failed to find any specific difference from our species, attains, according to Jordan, a length of nearly 3 ft. on the Californian coast.

[c] On an average about 49 or 50 %, but in the males generally less than 47 %, in the females more, and in the latter sometimes as much as 53 %. In comparison with the total length of the body, it is a rule that in the males the greatest depth of the body is less than, in the females more than or equal to, 40 % of the length of the body to the end of the caudal fin.

[d] One specimen has 24 teeth in an outer row and 8 in an inner row, the latter being set at about the middle of the outer row.

The nostrils resemble those of the Plaice, both in form and position; but the anterior are somewhat more distinctly incised in an oblique direction at the top, and their pointed marginal flaps are somewhat longer and more distinct. The eyes are set on the left side, at least half as often, if not in quite so many cases, as on the right. Their position is the same as in the Plaice, but their size is less. In specimens between about 16 and 26 cm. long the longitudinal diameter of the eye is about 16 or 17 % of the length of the head, and in specimens between 29 and 32 cm. long about 15 or 14 %.

In this species also, the body is furnished with cycloid scales, imbricated only at the end of the tail and on the base of the caudal fin, and these smooth scales are more or less deeply imbedded in the thick skin. But their occurrence is confined, in ordinary cases, to the intervals between the spaces covered by sharp, spinous scales. Sometimes they are scarce, or may even be wanting on certain parts of the body. The spinous scales are either ordinary ctenoid scales, with spines only at the hind (free) margin, or transformed into spinous warts, with erect spines all round their surface. These scales or warts occur on both sides of the lateral line and on the head; but their number is very different in different specimens. In some cases they are scattered over the whole of the coloured side of the body, thickest, however, at the sides of the lateral line. On the blind side they appear generally at the lateral line and seldom on the belly. The greater portion of the blind side of the head is always naked. At the base of each fin-ray, but set in the spaces between the roots of the rays, both in the dorsal and the anal fins, we find a large spinous wart. This row of warts seldom extends, however, to the end of the fin on the tail, and in most cases it is double on the anterior part of the body. In some cases the body is entirely smooth, with the exception of the spinous warts at the bases of the dorsal and anal fin-rays and a few on the head and at the lateral line. This is the case with the variety brought home from Archangel by Lieutenant SANDEBERG and described under the name of *Pleuronectes Bogdanovii*, of which equally typical specimens may be found in the Baltic. Among the varieties of *flesus* this form is evidently a deviation in the opposite direction to that taken among the varieties of *platessa* by *pseudoflesus*; and thus the two species approach each other in their varieties.

The lateral line, which begins at the bent, osseous ridge on the head, forms a curve that is often scarcely perceptible, above the pectoral fin, and then runs straight out to the extreme tip of the middle ray of the caudal fin. On an average we find 76 pores in this line on the body, and 26 on the caudal fin.

The dorsal fin begins, as in the preceding species, above the upper eye, but ends at a distance from the caudal fin that may sometimes be equal to the least depth of the tail, and is at least 80 % thereof or 35—46 % of the postorbital length of the head. The base of the dorsal fin as a rule occupies about 77—83 % (sometimes as much as 86 %) of the length of the body to the base of the caudal fin. Its greatest height, which generally occurs between the 27th and 33rd rays (on an average at the 30th) from the beginning, is about 13—16 % (on an average $14^{1}/_{2}$ %) of the length of the body *minus* the caudal fin. All the rays are simple and scaleless[a]. The anal fin, which is analogous to the dorsal in shape and structure, begins at a distance from the tip of the snout which, in our specimens, is never less than 40 % (in most cases between 41 and 46 %) of the length of the body to the base of the caudal fin. Its greatest height, which occurs between the 13th and 16th rays (on an average at the 15th), is generally somewhat greater than that of the dorsal fin[b]; but the length of its base is only seldom 60 % (generally between 51 and 58 %) of the length of the body *minus* the caudal fin. The pectoral and ventral fins essentially correspond to those of the Plaice; but in the former the length of the first ray is more than half, or at least half, that of the second ray or even of the third, which is the longest. The caudal fin is of the same shape as in the Plaice, and its length in our specimens varies between 19 and 23 % of that of the rest of the body; but the number of the branched rays has constantly proved to be no more than 12. Vent and anal spine as in the Plaice. The former, however, is comparatively large, and is furnished on the eye side with a urogenital papilla, which in the specimens examined by us has generally seemed to be better developed than in the other species of the genus.

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[a] NORDMANN (l. c.) states, however, with regard to the Black Sea form, that of 12 specimens 2 were furnished with "ciliated scales on the middle rays of the dorsal and anal fins." In two small specimens, respectively 13 and 14 dcm. long, which HEDENBORG has sent home to Stockholm from the Bosphorus, the middle rays of the dorsal and anal fins are also rough with scattered, spiny scales. These specimens are entirely destitute of ctenoid scales on the body with the exception of the usual row of spinous warts — and these are small — along the bases of the dorsal and anal fins, and the bony tubercles on the cranial osseous ridge between and behind the eyes. This ridge, by its extraordinary breadth behind, reminds us very much of the Arctic forms which we are just about to describe.

[b] In 12 full-grown specimens the greatest height of the anal fin measures on an average $15^{1}/_{2}$ % of the length of the body *minus* the caudal fin.

In order to account for the external relations between the Plaice and the Flounder, and to give the most important changes of growth in the two species — excluding their earliest stages — we here append the following table of averages:

Average in		[illegible]		[illegible]	
Length of the body expressed in millimetres ..		257	[illegible]	251	295
Length of the head .	in % of the length of the body	[illegible]	23.3	[illegible]	25.5
Greatest depth of the body .	.. ..	39.7	42.6	41.0	41.3
Least	.. ..	7.8	[illegible]	7.7	7.3
Postorbital length of the head	.. ..	15.3	15.9	15.6	[illegible]
Length of the head	in % of the greatest depth of the body	57.7	[illegible]	57.8	[illegible]
Postorbital length of the head..........	.. ..	[illegible]	[illegible]	38.5	40.8
Length of the branch of the lower jaw on the blind side..........	in % of the length of the body	8.1	[illegible]	[illegible]	8.7
.. .. [illegible] .. .	.. ..	7.6	[illegible]	7.9	8.1
.. .. .. base of the dorsal fin .	.. ..	[illegible]	[illegible]	67.3	[illegible]
.. .. [illegible] ..	.. ..	53.2	[illegible]	[illegible]	45.9
.. .. .. longest ray of the dorsal fin	.. ..	11.2	11.5	12.0	12.1
.. . . anal	.. ..	11.5	[illegible]	12.5	[illegible]
Distance between the anal fin and the tip of the snout ..	.. ..	[illegible]	[illegible]	[illegible]	36.6
Length of the pectoral fin of the eye side...................... .	.. ..	10.1	10.2	11.6	11.3
.. .. .. ventral	.. ..	8.0	8.3	[illegible]	[illegible]
.. .. .. middle rays of the caudal fin ..	.. ..	18.3	19.0	17.6	[illegible]

The internal organs of the Flounder also correspond in the most essential respects to those of the preceding species. The liver is undivided and oblong, and lies on the left side. The spleen is dark red, round on one side and flat on the other, and lies by the ventricle, close to the large, round gall-bladder. The intestine is about $1\frac{1}{2}$ times as long as the whole fish, and lies in coils, without any regular curves, of almost uniform diameter, and without any considerable distension. It is furnished with two very short pyloric appendages. The heart is long and quadrangular. The milt-sacs of the male are double and heart-shaped, and lie at the extreme end of the abdominal cavity. The ovaries of the female are also double as usual, very long and pointed; only the broad anterior end lies in the abdominal cavity, the long tips being furnished, as in the other Flatfishes, with special cavities, one on each side of the base of the anal fin. This double cavity extends almost to the end of the anal fin.

The coloration is highly variable. On the eye side it is generally gray or yellowish gray, in most cases marked with round, pale orange spots, which also occur on the fins. The fins are of the same colour as the body, but somewhat lighter. The blind side is white, but often spotted with brown, especially along the lateral line. In specimens where half this side is brown, the brown colour always belongs to the caudal part. Sometimes, though extremely seldom, the blind side is entirely brown. The iris is brassy-yellow, the pupil blue. Among the numerous colour-varieties of this species there is one, which the Royal Museum has received both from the White Sea and the Baltic, with the eye side of a uniform blackish blue or plum-colour. Shaw describes a *Pleuronectes roseus*[a] "of the most delicate rose-colour, slightly tinged in some parts with yellowish, and in others with silvery white." This form was taken in the Thames, and was without any spinous warts or ctenoid scales. Brown[b] tells us of a flesh-coloured variety (*Platessa carnaria*), with irregularly dispersed, dark spots. NORDMANN describes (l. c.) a *Pl. flesus*, var. *marmorata*, from the Black Sea, in which the eye side was milk-white, with irregular, vermiform and roundish, brown spots, edged with orange.

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[a] *Gen. Zool.*, vol. IV, *Pisc.*, p. 302. Cf. Day, l. c.

[b] Edinb. Journ. Nat. Geol. II, p. 99, plate II.

The Flounder is the commonest species of the genus, both in the North Sea and the Baltic. Even in the island-belt of Stockholm and off Åland it is common, as well as in the west of the Gulf of Finland and in the south and central parts of the Gulf of Bothnia. From Hudiksvall Dr. WISTRÖM has forwarded to the Royal Museum specimens up to a length of 32 cm. North of Qvarken or, according to MELA, in Lat. 64°N., however, it becomes extremely rare, if indeed it occurs at all in this northernmost part of the Gulf of Bothnia. In the Atlantic it is equally common all round Europe, from the White Sea to the Black Sea. Lieutenant SANDEBERG brought home numerous specimens from the Dwina, off Archangel; and according to his collections, the Flounder there attains a length of at least 30 cm. Strangely enough, it is not yet known with certainty in Iceland[a] or Greenland[b]; but *Pleuronectes stellatus*, which PALLAS found in Kamchatka, RICHARDSON at the mouth of the Coppermine River (on the Arctic coast of North America), and JORDAN in California, can scarcely be regarded as a distinct species from the Flounder. If these forms are identical, the species must attain a far more advanced stage of development in the Pacific, and a far greater value in California, than it does here.

The Flounder prefers a sandy, soft, or weedy bottom. All the summer it lives in shallow water, and retires to deeper water only in winter, when it is seldom to be found near shore. It lives chiefly on mollusks and crustaceans. It surpasses its kindred species in the capability which it possesses in a high degree, of thriving in only slightly brackish or even fresh water. LINDSTRÖM obtained specimens that had been "perfectly acclimatised to the fresh water of Alnäse Swamp" in Gothland, and he also received "conclusive evidence that they live in Ejke Swamp." Into a tributary of the little Rönne, that falls into Skelder Bay, according to NILSSON, it penetrates to a distance of more than 10 kilometres from the sea. According to MALM it goes more than 25 kilometres up the River Gotha, and is often taken off Kongelf. It also ascends the tiny stream Qvistrum in Bohuslän, above the falls at Qvistrum. COLLETT quotes a number of places in Norway, up to the extreme north, where it not only ascends the rivers, but also makes its way into the lakes, and breeds there. KRØYER and FEDDERSEN give similar instances from Jutland, Fünen, Laaland, and Zealand. The English writers too, from WILLUGHBY's[c] time, and the French, from BELON's[d], also make the same statement with regard to the Flounder in their own countries. SIEBOLD (l. c.) has collected observations on this head from Belgium and Germany, where this fish goes a long distance up the Schelde and Maas with their tributaries, and also up the Rhine, in the watershed of which it has been caught in the Moselle off Treves, off Mayence, and far up the Main.

In the north of the Cattegat EKSTRÖM found the Flounder full of roe at the end of March. In the Baltic it spawns in May. It prefers to spawn on shelving coasts. The roe is whitish yellow, and the eggs are somewhat smaller than those of the Plaice. COLLETT estimated the number of eggs in a middle-sized Flounder at 413,000. According to HENSEN the eggs float freely at the surface, and are from 1·15 to 1·27 mm. in diameter; while the newly hatched fry are about 3·6 mm. long, without pigment in the eyes, and with the vent, which lies close to the vitelline sac, united to the intestine only by a fine string. Off Aspö, outside Carlskrona, we have found Flounder fry between 19 and 32 mm. long at the middle of July. In the Cattegat, "at midsummer", KRØYER found young specimens between 65 and 78 mm. long, which he assumed to belong to the fry of the same year[e]. Some young specimens 130 mm. long that were taken on the same occasion, he considered to date from the spawning-season of the previous year.

As an article of food the Flounder is one of those Flatfishes that are in least request, though it is generally considered superior to the Dab. In winter especially, the flesh is flabby, and contracts a muddy flavour, if the fish lives on a bottom of this nature. The Flounder seems also to acquire a better flavour in fresh or brackish water than where the water is really salt[a]. The Flounders of the Loire and Seine are highly esteemed, according to Blanchère. "Fresh water," he says[b], "has the effect of ridding the Flounder of that oozy smell that it has in the sea." In the Baltic too, where the percentage of salt in the water is comparatively low, the Flounder enjoys a good reputation. "It is one of the most delicate fishes of the island-belt of Mörkö," says Ekström, "especially when the summer is somewhat advanced. At this season it is very fat and dainty — hence the proverb: *När skogen är grön, är flundran skön* (when green is the wood, the Flounder is good). Much depends, however, on the method of dressing it. Where Flounders are taken in large quantities they are usually salted or dried. In the island-belt of Mörkö there is a local method of preparing them in the following manner. "The fish are gutted, lightly salted, and after they have lain a day in the salt, hung up to dry. They are then kept for future emergencies, and when required for use, are baked on straw in an oven. Prepared in this way they are delicious, provided that they are not so old or badly preserved that the flesh is rank." Smoked Flounders are also a favourite dish in many places, especially in Denmark and the north of Germany. The utility of the Flounder, however, does not save it from being despised where it is taken in too great abundance. Krøyer tells us that on the west coast of Zealand, at the beginning of May, he once witnessed the taking-up of a bottom-net which was found to be almost full of Flounders. As many as the large fishing-boat could hold — about half the catch — were taken on board, and the rest were released from the net. When the boat reached shore, nine men took one basketful of Flounders each, while the rest were left to rot in the boat and on the beach. According to Thompson considerable quantities of this fish were brought to Belfast in his time[c], but their value was so low that one Plaice was worth as much as a hundred Flounders. According to Pallas his *Pleuronectes stellatus* was thrown away on the shore, and left to lie there in large heaps. In Alaska, on the other hand, according to Bean[d], it is of great economical importance; and in San Francisco, according to Jordan[e], it is much esteemed, though large specimens (between 8 and 20 lbs. in weight) are sold cheap and not considered good eating.

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[a] FABER (*Naturg. Fisch. Isl.*, p. 144) included it among the fishes of Iceland with great hesitation and only on the authority of prior statements by OLAVIUS and MOHR. He never met with it himself in Iceland.

[b] COUCH states (*Hist. Fish. Brit. Isl.*, vol. III, p. 195) that the Flounder is known in Greenland, but he gives no authority for his statement; and it is not included in LÜTKEN's list of the fishes of Greenland (Rev. Cat. 1875).

[c] *Hist. Piscium*, p. 98.

[d] *Passer fluviatilis*, vulgo *flesus*, BELON: *De Aquat.*, p. 144.

[e] Cf. the remarks on the growth of the fry of the preceding species.

The Flounder bears many names. As it is the most common of our Flatfishes, it is known in most parts of Sweden by the general name of *flundra* (Flatfish). In the island-belt of Tjörn it is called *Skrubba*, *Skrubbskädda*, *Ruskeskädda* (because it is often taken in *ryssjor* = traps) and *Ruska*. According to Lindström the fishermen of Gothland "distinguish between two colour-varieties, *Sandflundre*, more whitish gray on the eye side and an inhabitant of sandy spots, and *Bullerflundre*, which is blackish gray and lives on a stony and dark-coloured bottom." According to Gottsche the Danish fishermen distinguish between *Mudderskrubbe* (Mud-flounder), generally dextral and with a great part of the surface of the body destitute of spinous scales, and *Sandskrubbe*, generally sinistral and with the eye side of the body almost entirely covered with spinous scales.

The Flounder is taken chiefly in nets (*skäddegarn*), and sometimes together with other fishes in the seine or in fixed engines, such as traps and bottom-nets; but it also readily takes a hook baited with worms, and is thus often taken on long-lines set for Eels.

(Ekström, Smitt.)

The Plaice and the Flounder have proved to be extremely variable species, and to be fairly closely approximated to each other by their varieties. The variety of the former which Gottsche called *Platessa Pseudoflesus* — with ciliated scales, most distinct in a row along the bases of the dorsal and anal fins and on the sides of the lateral line — and the variety of the Flounder which Sandeberg called *Pleuronectes Bogda-*

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[a] Lindström says, however, of the Flounders in the swamps of Gothland, that their flesh is "of inferior flavour and muddy."

[b] *Dict. Gen. d. Pêches*, p. 319.

[c] *Nat. Hist. Irel.* (1856) vol. IV, p. 194.

[d] *Cat. Collect. Fish.*, Gt. Intern. Fish. Exhib. Lond. 1883, U. S. Amer. Cat. *F.* pp. 5 and 20.

[e] Br. Goode, *Fish.*, *Fish. Industr. U. S.*, sect. I, p. 184.

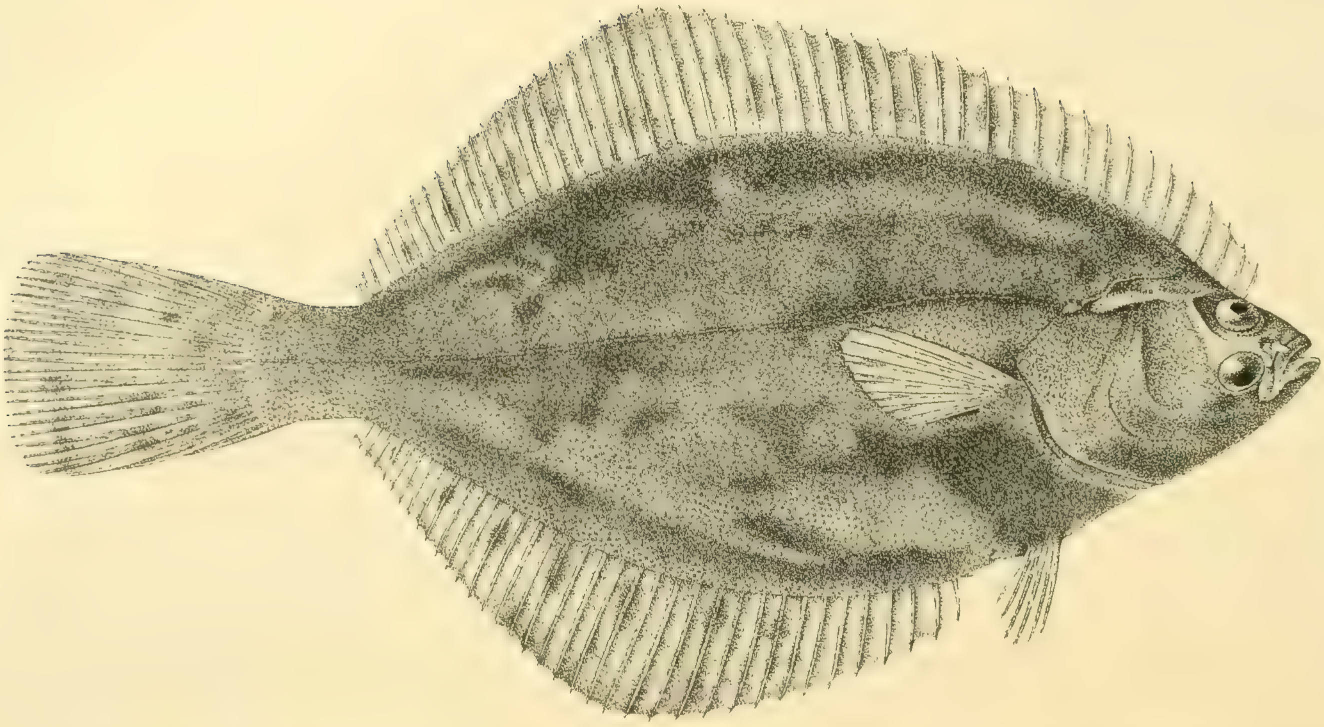

Fig. 110. *Pleuronectes glacialis.* Variety named by PALLAS *Pleuronectes cicatricosus.* Natural size. Forwarded from Archangel by H. SANDEBERG.

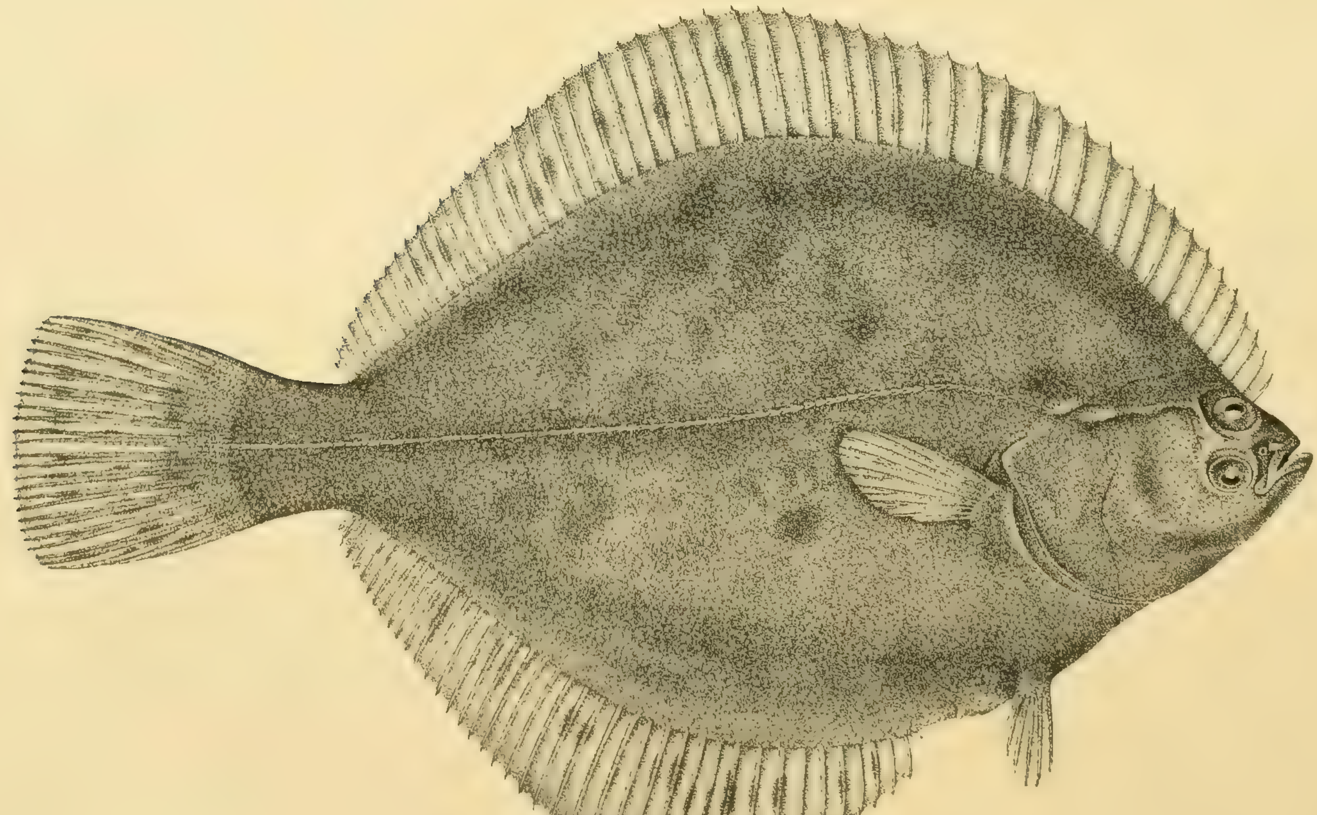

Fig. 111. *Pleuronectes glacialis.* Variety named by GÜNTHER *Pl. franklinii.* Natural size. From Najtschkaj (N.E. Siberia). 7th April, 1879, Vega Expedition.

norii — with the surface of the body almost entirely smooth, with the exception of the weak spinous warts at the spots mentioned and thinly scattered on the head — lead us to the following conclusion. The character drawn from the covering of scales, which gives us one of the most important external distinctions, has developed from an original type common to both species. We are apparently guided to this original type by a comparison between these two species and a third, *Pleuronectes glacialis*, which has a wide geographical range in the North, and is as variable as either of the others. This northern species has also borne many names: *Pleuronectes glacialis*[a], *Pl. cicatricosus*[b], *Platessa glabra*[c], *Platessa dvinensis*[d], *Pleuronectes franklinii*[e] and *Euchalarodus putnami*[f]. The first two names refer to the two distinct varieties (figs. 110 and 111) which Pallas knew from the European and Siberian coasts of the Arctic Ocean; the third, the fourth, and the last names were conferred on the species on the Atlantic coast of North America — where it has been found as far south as Salem — and on the Arctic coast of Europe. The last name but one has reference to the species as it occurs on the Arctic coast of North America. In Greenland and Iceland, up to the present at least, the species has not been found.

Pleuronectes glacialis is distinguished both from the Plaice and the Flounder by the greater depth of the tail, the least depth of which is always more than 9 % of the length of the body — a measurement we have found in the Plaice only exceptionally, and never quite exactly, though very nearly so. This greater depth of the tail gives to *Pl. glacialis* the same character as *Pl. limanda* acquires by the comparatively small size of the head, the least depth of the tail being more than 36 % of the length of the head; while in *Pl. platessa* and *Pl. flesus* this proportion is always — to the best of our knowledge with only one single exception — less than 35 %. Another character, which on the other hand really ranges *Pl. glacialis* in immediate systematic proximity to *Pl. limanda*, consists in the scales of the body. By far the greater part of the eye side, or at least those parts where the scaly covering is strongest in the two preceding species, are clothed with ciliated scales, in type the same as those of *Pl. limanda*, but shorter (smaller) and scattered, never imbricated, but rather set in a quincunx; and as a rule, one row of these scales advances at least over the middle rays of the dorsal and anal fins. As usual, however, the scales may also vary in *Pl. glacialis;* and sometimes the ciliated scales occur only on the eye side, in a row along the bases of the dorsal and anal fins, while they are sometimes close-set and contiguous, but not imbricated, on the whole of the eye side. On the blind side they may be entirely wanting or well-developed and only slightly more scattered than on the eye side. In the number of the vertebræ, too, *Pl. glacialis* comes nearest *Pl. limanda.* According to our observations the former possesses 38 or 39 (according to Richardson 40) vertebræ, while *Pl. limanda* has 39 or 40. In this respect, therefore, both *Pl. glacialis* and *Pl. limanda* appear as intermediate forms between *Pl. flesus*, with 35—37 vertebræ, and *Pl. platessa*, with 43 or 44. By the shape of the lower pharyngeals and the structure of their teeth, however, *Pl. glacialis* is ranged in the same group as *Pl. flesus* and *Pl. platessa;* and in this respect it comes nearest the Plaice, in which these bones are narrower than in the Flounder. *Pl. glacialis* also comes nearest *Pl. platessa* in the number of gill-rakers, which varies on the first branchial arch between 9 and 12. In the cephalic characters *Pl. glacialis* is approximated most nearly to the Flounder by the bony ridge behind the eyes, which is continuous or broken up into only two or three oblong and blunt protuberances, and which widens posteriorly into a clavate form above the gill-cover (on the *os squamosum*), where it is interrupted to be again continued by an oblong protuberance, which is smaller, but just as rough with small osseous warts, on the posttemporal bone. This species also comes nearest *Pl. flesus* in the number of rays in the dorsal and anal fins (*D.* 51—64; *A.* 37—45), though in this respect, too, one of its varieties distinctly approximates it to *Pl. platessa.*

Thus we find here a group of two varieties which, in its entirety as a species, forms a landmark between two other groups, but in the differentiation of its forms is so little advanced that both these varieties may also be ranged as intermediate forms between two species of one of the other groups[a]. The first group must, therefore, stand nearest the presumable original type of all three groups, unless, indeed, it may be shown that it *is* that original type.

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[a] Pall., *Russische Reise*, Theil III, Anhang, p. 706.

[b] Pall., *Zoographia Rosso-Asiatica*, tom. III, p. 292.

[c] Storer, Proc. Bost. Soc. Nat. Hist., I (1843), p. 130.

[d] Lilli., Vet.-Akad. Handl. 1850, II. p. 306.

[e] Gthr. *Cat. Brit. Mus., Fish.*, vol. IV, p. 442.

[f] Gill, Proc. Acad. Nat. Sc. Philad. 1864, p. 222.

When LILLJEBORG first discovered his *Platessa dvinensis*, he suspected that it was identical in species with PALLAS's *Pleuronectes cicatricosus:* and in this suspicion he was undoubtedly right. In another passage[b] we have combined this species with STORER's *Platessa glabra;* but the collections of the Vega Expedition prevent us from following JORDAN and GILBERT's example[c], and unreservedly uniting into one single species the two species described by PALLAS, *Pl. glacialis* and *Pl. cicatricosus*. PALLAS based his distinction between these species chiefly on the deeper form of the body and the closer scaly covering of *Pleuronectes glacialis.* This difference reappears, even though it is modified by differences of age and sex, between the specimens of *Pl. glacialis* brought home by NORDENSKIÖLD's Expedition of 1875 from Chabarowa and by the Vega Expedition from Najtschkaj (N.E. Siberia) and the numerous examples of *Pl. cicatricosus* brought home by Lieutenant SANDEBERG from Archangel. According to these collections the following distinctions are valid:

	Pl. glacialis fr. Najtschkaj.	*Pl. cicatricosus* fr. Archangel.
Greatest depth of the body in % of the length of the body	41 (Average: 43.9)	< 41 (Average: 39.2)
Length of the head in % of the greatest depth of the body	57[d] (Average: 51.5)	> 57[d] (Average: 61.7)
Postorbital length of the head in % of the greatest depth of the body	< 38[d] (Average: 35.5)	> 40[d] (Average: 42.5)
Length of the head in % of the greatest distance between the lateral line and the ventral edge	< 93[d] (Average: 86.3)	93 (Average: 101.6)

Although these differences are not great, and although, considering the variability of the kindred species, they seem rather to belong to varieties, still they exist, to judge by 9 specimens of *Pl. glacialis* and more than 20 of *Pl. cicatricosus:* and so long as a character proves tenable, we have no right to reject the distinction based on it, whether we choose to regard the latter as a distinction of species or merely of variety. As is generally the case in the Scandinavian Flatfishes, the females are in the majority, and this to such an extent that we have not found a single male among the specimens of *Pl. cicatricosus.* However, this does not affect the significance of the differences given here, as it is by the shallower (narrower) form of the body that the males are externally distinguished, and in *Pl. cicatricosus* they would thus only have still further diminished the average depth of the body.

PALLAS obtained his *Pleuronectes cicatricosus* from the basin of the Pacific[e] and *Pl. glacialis* from Kara Sea and the Gulf of Obi[f]; and it would thus appear that the former belonged to the east, the latter to the west, of the Arctic Ocean and the Old World. But we have no recorded observation of *Pl. glacialis* west of Nova Zembla, while *Pl. cicatricosus*, on the other hand, must be recognised as common in the White Sea. According to GÜNTHER's description[g] of the type-specimen of RICHARDSON's *Pl. glacialis*, from Bathurst Inlet (the middle of the Arctic coast of North America) this specimen really belongs to the form thus entitled by PALLAS. On the other hand, the Alaskan species described under this name by JORDAN and GILBERT and figured by TODD[h], evidently possesses the characters of *Pl. cicatricosus*, of the occurrence of which on the Arctic coast of North America east of Alaska we have no recorded observation, though it is common and known by the name of Christmas-fish at Salem, on the Atlantic coast of the United States. The latter species is just as little known to the north of Asia, west of Behring Strait. In its geographical range there thus appear, as far as we know at present, three great gaps, the first north of North America, the second north of Asia, and the third straight across the Atlantic. The first two gaps are filled, at least in part, by the variety *Pl. glacialis*, which seems to be a purely Arctic form, while *Pl. cicatricosus*, of the White Sea and the coast of Alaska, lives in a comparatively milder Arctic climate. On the west coast of the United States the geographical range of the latter species extends much further south, in common with that of several other Arctic species, which, on account of the set of the ocean-currents, may there appear in much more southern latitudes than on the east side of the Atlantic.

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[a] LILLJEBORG also says of his *Platessa dvinensis:* "It seems to be an intermediate form between *Plat. vulgaris* and *Plat. flesus.* By the structure of the teeth it is approximated to the former, and by the covering of the body and the coloration to the latter."

[b] *Ur var tids forskning* (RETZIUS), No. 29, p. 59.

[c] Bull. U. S. Nat. Mus., No. 16, p. 837.

[d] An exceptional case.

[e] "Specimina e mari inter Camtschatcam et Americam lecta mihi retulit D. D. MERK."

[f] "In littoribus vadosis maris glacialis ad Sinum Carensem et Obi fl. ostia legit BASIL SUJEF." Chabarowa, where NORDENSKIÖLD's Expedition of 1875 found *Pl. glacialis*, lies off Jugor-scharr, just at the division between Kara Sea and the Murman Sea.

[g] *Brit. Mus. Cat., Fish.*, vol IV, p. 442; *Pleuronectes Franklinii.*

[h] BR. GOODE, *Fish., Fish. Industr. U. S.*, sect. I, pl. 47.

Though *Pleuronectes glacialis* has not been found within the true limits of the Scandinavian fauna, in spite of the fact that it lives in their immediate vicinity, still it is of especial interest from a systematic point of view, as the relations between its two forms throw a considerable light on those between the Flounder and the Plaice. As it is also easier for us in this way to gain a general view of the relation between these species and the Dab, we here give a table of averages for the most important characters of these five forms:

Average in	*Pleuronectes limanda.*	Pleuronectes glacialis.			*Pleuronectes cicatricosus.*	*Pleuronectes platessa*	*Pleuronectes flesus*
	♂ + ♀	♂ + ♀	♂	♀	♂	♂ + ♀	♂ + ♀
Length of the body, expressed in millimetres	236	198	204	194	195	297	269
,, ,, ,, head in % of the length of the body	20.7	22.5			24.3	23.0	24.0
Greatest depth of the body ,, ,, ,,	38.9	43.9	41.5[a]	45.2	39.2	40.8	41.1
Least ,, ,, ,, ,,	8.5	9.6	—		9.4	7.9	7.5
Postorbital length of the head ,, ,, ,,	12.2	15.5	—	—	16.7	15.5	16.1
Length of the head in % of the greatest depth of the body	53.0	51.5	—	-	61.7	56.6	58.5
Postorbital length of the head ,, ,, ,,	31.4	35.5	—	—	42.5	38.0	39.1
Length of the branch of the lower jaw on the blind side in % of the length of the body	8.3	7.8			8.5	8.2	8.4
,, ,, ,, ,, ,, ,, ,, ,, ,, eye ,, ,, ,,	7.7	7.3	—		7.8	7.6	8.1
,, ,, ,, base of the dorsal fin ,, ,, ,,	68.6	69.7	—		69.5	69.5	66.8
,, ,, ,, ,, ,, ,, anal ,, ,, ,,	53.9	50.5	--	-	48.3	53.2	46.5
,, ,, ,, longest ray in the dorsal fin ,, ,, ,,	11.7	11.4	13.1[b]	10.3	10.7	11.3	12.1
,, ,, ,, ,, ,, ,, ,, anal ,, ,, ,,	11.7	11.8	13.4[c]	10.9	10.7	11.6	12.5
Distance between the anal fin and the tip of the snout ,, ,, ,,	30.4	34.4	--	—	34.8	30.6	35.8
Length of the pectoral fin of the eye side ,, ,, ,,	13.0	13.3	15.9[d]	11.7	12.8	10.1	11.5
,, ,, ,, ventral ,, ,, ,,	7.8	9.0	10.1[e]	8.5	8.3	8.1	7.7
,, ,, ,, middle rays of the caudal fin ,, ,, ,,	17.9	17.1	18.2[f]	16.5	16.8	18.6	17.2

This table, which also contains the appreciable sexual differences in var. *Pl. glacialis* (*franklinii*), shows in the first place that in the great majority of cases where the percentage in *Pl. glacialis* is higher than in *Pl. cicatricosus*, the percentage in *Pl. platessa* is also higher than in *Pl. flesus*, and that where it is lower in the first form than in the second, it is also lower in *Pl. platessa* than in *Pl. flesus*. Thus, in most cases the difference of form in the first two varieties runs in the same direction as in the last two species. If we further compare this table with the table given above (p. 401) of the changes of growth in the Plaice and the Flounder, we easily find that, in all those relations in which the changes of growth of these two species show a distinct and common direction of development, the juvenile stages are represented either by *Pl. limanda*, *Pl. glacialis* or *Pl. cicatricosus*, or by two of these forms in common. This series of forms, which, as far as we know at present, culminates in the Plaice and the Flounder, thus seems to have originally started either from one of these three forms or in close systematic proximity to them.

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[a] Maximum percentage in ♂ < 43·0.
Minimum ,, ,, ♀ > 43·0.

[b] Minimum ,, ,, ♂ > 12·0.
Maximum ,, ,, ♀ < 12·0.

[c] Minimum ,, ,, ♂ > 12·0.
Maximum ,, ,, ♀ < 12·0.

[d] Minimum ,, ,, ♂ > 15.0.
Maximum ,, ,, ♀ < 14·0.

[e] Minimum ,, ,, ♂ > 9·0.
Maximum ,, ,, ♀ < 9·0.

[f] Minimum ,, ,, ♂ > 17·2.
Maximum ,, ,, ♀ < 17·2.

SUBFAMILY **HIPPOGLOSSINA.**

Snout not elongated, the lower jaw most prominent. Mouth middle-sized or large and only slightly oblique: jaw-teeth almost as well-developed on the eye side as on the blind side. Ventral fins one on each side of the ventral margin, and their rays close together at the base. Eyes large or at least middle-sized. Pseudobranchiæ and, in most cases, gill-rakers well-developed.

This subfamily derives its name from the well-known Halibut, *Hippoglossus*, and contains about 30 described species, distributed among 5 or, if we please, as many as 9, distinct genera: (*Psettodes* + *Atherestes*), (*Hippoglossus* + *Platysomatichthys*), (*Paralichthys* + *Pseudorhombus*), (*Drepanopsetta* + *Psettichthys*) and *Tephritis*. The most numerous and the largest species live in the North, but several belong to the tropical seas, to West Indian, East Indian, Chinese and Japanese waters.

The peculiarity which we have remarked above as characteristic of the juvenile stages of the true Flounders (subg. *Platessa*, auctt.), the pointed jaw-teeth set in several rows, in this subfamily as well as in the following one, is the rule even in adult specimens. The principal characteristic of these two subfamilies lies, however, in the fact that the asymmetry of the head has only slightly affected the structure of the jaws. Thus, the jaw-teeth of the eye side may be almost or even quite as well-developed as those of the blind side. On the other hand, the subfamily of the Halibuts comes nearer the preceding Flatfishes in the position of the ventral fins and the form of the pelvic bones. In essential respects at least, the ventral fins are symmetrical in position, one on each side of the ventral margin; and the pelvic bones are of the normal Heterosomatous form, a narrow triangle, and hang, closely united to each other, backwards and downwards or straight downwards (ventrally) from the inner side of the coalescent clavicular bones, being suspended within and somewhat above the lower end of the coracoid bones. To the outer side of the short base of the triangle are attached, as usual, the rays of the ventral fins, with their roots (articulations) close to each other. Another character that seems to be common to the members of this subfamily lies in the circumstance that all the caudal vertebræ are entirely without transverse processes or possess only very slight traces thereof.

The Scandinavian fauna contains only two, or, if we choose, three, genera of this subfamily, each genus, in the latter case, with only one species.

A: Jaw-teeth, in the upper jaw at least, set in two or more rows. Scales cycloid.	
a: Lower pharyngeal teeth set in two rows. Lateral line sharply arcuate in front, above the pectoral fins	*Hippoglossus vulgaris.*
b: Lower pharyngeal teeth set in a single row. Lateral line evenly sloping in front........	*Platysomatichthys hippoglossoides.*
B: Jaw-teeth set in a single row[a]. Scales ctenoid. Lower pharyngeal teeth set in two irregular rows. Lateral line evenly sloping	*Drepanopsetta platessoides.*

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[a] Does not apply to all exotic species of the genus.

GENUS HIPPOGLOSSUS.

Body comparatively elongated, of a pointed oval shape, and somewhat thick (fleshy). The eyes set on the right side and far apart from each other. Jaws and pharyngeals armed with pointed, mostly bent teeth, set in several rows or in a card. No palatine or vomerine teeth. The dorsal fin begins above the upper eye, which is set high. Hind margin of the caudal fin concave. Anal spine present, though short. Scales small and cycloid. Lateral line sharply arcuate in front.

The solitary species of this genus has borne the name of *Hippoglossus*, i. e., large tongue[a], ever since the time of RONDELET. LINNÆUS employed this name in a specific signification; but CUVIER[b], following his unfortunate custom, here as in many other cases employed the Linnaean specific name to denote a subgenus, and it has since been raised, still more unfortunately, by FLEMING[c] to the rank of a generic name.

THE HALIBUT (SW. HELGEFLUNDRAN).

HIPPOGLOSSUS VULGARIS.

Plate XVII, figs. 1 and 2.

Greatest depth of the body in young specimens (about $^{1}/_{3}$ m. long) about 31 % of its length, in somewhat older ones (about $^{1}/_{2}$ m. long) about 34 or 33 % thereof, and in still older specimens about 30 or 29 % thereof. Greatest thickness about $^{1}/_{4}$ — during youth nearer $^{1}/_{5}$ — of the depth of the body. Least depth of the tail less than 24 % of the greatest depth of the body. Lateral line sharply arcuate in the abdominal region. Length of the lower jaw less than half that of the head[d]. Hind extremity of the upper jaw-bone extending back almost to the perpendicular from the middle of the lower eye. The dorsal fin begins at the anterior part of the upper eye, its greatest height (the longest ray) occurring exactly opposite the greatest height of the anal fin, at about the middle of the length of the body minus the caudal fin. Coloration of the eye side in old specimens blackish, in younger ones chocolate-brown, marbled with a lighter tint; blind side white.

R. br. 7: *D.* 99—104[e] (= x + 5—12[f]): *A.* 73—79[g] (= x + 8—13[h]): *P.* 2 + 13 l. 14: *V.* 2 + 4; *C.* x + 15 + x; *L. lat.* 159—163 (+13—15 in pinn. caud.)): *Vert.* 51 (=16+35).

Syn. *Pleuronectes* oculis a dextra, totus glaber, ART., *Gen. Pisc.*, p. 17; *Syn.*, p. 31; LIN., *Fn. Suec.*, ed. II, p. 113, No. 302.

Pleuronectes Hippoglossus, LIN., *Syst. Nat.*, ed. X, tom. I, p. 269; MÜLL., *Zool. Dan. Prodr.*, p. 44; FABR., *Fn. Groenl.*, p. 161; BL., *Fisch. Deutschl.*, pt. 2, p. 47, tab. XLVII; QVENSEL, Vet.-Akad. Handl. 1806, p. 225; PALL., *Zoogr. Ross. Asiat.*, tom. III, p. 421; NILSS., *Prodr. Ichth. Scand.*, p. 57; SCHAGERSTR., Physiogr. Sällsk. Tidskr. (H. 3), p. 312; FABER, *Fisch. Isl.*, p. 148; VALENC., *Voy. Isl.*, cett. (GAIM.), *Poiss.*, pl. 14; LILLJ., Vet.-Akad. Handl. 1850, p. 333.

Hippoglossus vulgaris, FLMNG, *Brit. Anim.*, p. 199; DEK., *N. Y. Fn.*, pt. IV, p. 294, pl. XLIX, fig. 157; THOMPS.,

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[a] "Græci enim rei magnitudinem indicant βου et ἱππο particulis, ut in ἱπποσέλινον, ἱππομάραθρον. Sic hippoglossum dicimus a magnitudine, non a similitudine cum hippoglosso herba." ROND., *De Pisc.*, lib. XI, cap. XVI. p. 325.

[b] *Règne Animal*, 1817, tome II, p. 221.

[c] *Brit. Anim.*, 1828, p. 199.

[d] The branch of the lower jaw on the blind side, however, may sometimes be equal in length to half the head.

[e] Sometimes 98, according to QVENSEL and LILLJEBORG.
,, 107, ,, ,, BLOCH and DAY.
,, 110, ,, ,, FABER and MÖBIUS and HEINCKE.

[f] According to LILLJEBORG. In older specimens, however, even the 33rd ray, counting from behind, may be branched.

[g] Sometimes 81, according to GOTTSCHE.
,, 82, ,, ,, BLOCH and DAY.
,, 85, ,, ,, MÖBIUS and HEINCKE.

[h] According to LILLJEBORG. In older specimens, however, at least internal ramification may be traced even in the 24th ray, counting from behind.

Nat. Hist. Irel., vol. IV, p. 199; Gthr, *Cat. Brit. Mus.*, *Fish.*, vol. IV, p. 403; Coll., Forh. Vid. Selsk. Christ., 1874, Tillægsh., p. 134; ibid. 1879, No. 1, p. 74; Id., N. Mag. Naturv. Christ., Bd. 29 (1884), p. 98; Bean, Proc. U. S. Nat. Mus., vol. II (1879), p. 63; Winth., Naturh. Tidskr. Kbhvn, ser. 3, vol. XII, p. 36; Mor., *Hist. Nat. Poiss.*, *Fr.*, tom. III, p. 287; Jord., Gilb., Bull. U. S. Nat. Mus., No. 16, p. 819: Mela, *Vert. Fenn.*, p. 303, tab. IX; Day, *Fish. Gt. Brit.*, *Irel.*, vol. II, p. 5, pl. XCIV; Möb., Hcke, *Fisch. Osts.*, p. 87; Br.-Goode, *Fisher.*, *Fish.-Industr. U. S.*, sect. I, p. 189, pl. 54; Lillj., *Sv.*, *Norg. Fn.*, *Fisk.*, vol. II, p. 282.

Hippoglossus maximus, Minding, *Lehrb. Naturg. Fisch.* (Berlin 1832), sec. Gottsche, Arch. Naturg. (Wiegm.) 1835 (I, 2) p. 164; Kr., *Danm. Fiske*, vol. II, p. 381; Nilss., *Skand. Fn.*, *Fisk.*, p. 631.

Hippoglossus Linnei, Malm, *Gbgs*, *Boh. Fn.*, p. 508.

The Halibut is one of the largest Scandinavian fishes; and small Halibuts are almost rarer than middle-sized ones. Still we must regard as an exception, a marvellous exception — if indeed the statement be unreservedly to be relied on — the Halibut as long as an *Ottringsbaad* (a large fishing-boat), or about 18 ft. in length, which is said to have been seen in Norwegian Finmark. Olafsen[a] mentions that he saw a Halibut 10 Dan. ft. long in Iceland. Off Lofoden Kroyer saw a specimen slightly over 7 Dan. ft. long, which weighed 322 lbs., though it was very lean; while the largest specimen Nilsson obtained from Bohuslän was 6 ft. long and weighed only about 187 lbs. The fisherman who sold this fish to Nilsson in the winter of 1832, stated, however, that in the previous winter he had taken a Halibut off the Weather Islands that weighed 674 lbs. Instances of similar catches are given by A. Bremer[b] from Norwegian Finmark.

The body of the Halibut is more elongated than that of any of the preceding species, and sharply decreases in depth, especially towards the tail. The changes of growth, however, involve a considerable difference in this respect. In specimens about 350 mm. long we have found the greatest depth of the body to be about 31 % of the length, and in specimens between 360 and 450 mm. long about 33 or 34 % thereof, while in still older specimens the proportion sinks again to about 30 or 29 %. In our smallest specimen (a female 337 mm. long) the least depth of the tail was 6·8 % of the length of the body, and in a male 455 mm. long 7·2 % thereof; but subsequently this proportion also sinks at least below 6 %. We have never found this depth to exceed $22^{1}/_{2}$ % of the greatest depth of the body[c]. In the thickness of the body, however, the Halibut surpasses the preceding species. In young specimens, indeed, we may find the greatest thickness of the body to vary between only 20 and 25 % of the greatest depth; but in old specimens it is greater[d]. The thickness is also more symmetrical than in the preceding species, even the blind side being more fleshy, though not so much so as in the next species.

The head is distinguished from that of the preceding species by its smoother surface, which on the eye side is more evenly rounded, without projecting osseous ridges. In young specimens less than half a metre long its length is about 23—25 % of that of the body, while in older specimens this percentage sinks below 20 or even below 17. The superior and inferior profiles meet each other in front at fairly equal curves, which are regularly continued backwards to the deepest part of the body, which lies somewhat behind the end of the first third of its length, further back in old specimens than in young. In young specimens the lower jaw projects only slightly beyond the upper when the mouth is closed, in old specimens more; but the chin-protuberance is at least visible in young specimens, while in older ones it is almost obliterated. The eyes are middle-sized and fairly prominent, their longitudinal diameter in young specimens measuring 19 or 18 %, in old 16 or $15^{1}/_{2}$ %, of the length of the head. They are set almost in a line with each other, the upper being only slightly farther back than the lower. In young specimens about 175 mm. long, according to Collett, the breadth of the interorbital space is only half the diameter of the lens, while in specimens between 300 and 400 mm. long, it is about half the longitudinal diameter of the eye, and in older specimens may be at least almost equal to the diameter of the eye. The nostrils of the eye side are set fairly close to each other, just in front of and almost at the middle of the line drawn between the anterior margins of the eyes. The anterior nostril, the hind margin of which is prolonged into a semitubular dermal flap, is set at a distance from the tip of the snout that is about equal to the longitudinal diameter of the eyes. The nostrils of the blind side are set at the same distance from the tip of the snout and in the same relative position to each other, the anterior being also furnished posteriorly with a more or less nearly semitubular dermal flap; and are situated at the upper margin of the head, where the coloration of the eye side generally extends some way over the blind side. The jaw-bones of both sides of the body are fairly similar to each other in shape, and show a great likeness to the corresponding bones in the *Gadidæ*. The greatest asymmetry appears in the intermaxillary bones, the length of the intermaxillary bone of the eye side being sometimes only $^4/_5$ of that of the intermaxillary bone of the blind side. The nasal processes of these bones project above their upper margins $^1/_4$ (on the blind side) or $^1/_3$ (on the eye side) of the length of the bones themselves. Behind, in their upper margin — at two thirds of the distance along the intermaxillary bone of the eye side and half-way along that of the blind side — they are raised into a sharp projection, which evidently corresponds to the upright, more or less lobate process on the hind part of the intermaxillary bones in several Gadoid species. The maxillary bones are furnished with a similar but more process-like projection at the upper margin, at the end of the first third of their length. These bones differ only slightly from each other on both sides of the body, and the broadened hind extremity of the maxillary bone of the eye side extends back to a point almost vertically below the anterior margin of the pupil of the lower eye, or, in older specimens, below the middle of this eye. The branches of the lower jaw are also much alike, the length of that of the eye side being at least 92—97 % of that of the blind side; and their length, which is about 11 or 12 % of the length of the body, is always somewhat less than half that of the head. The jaw-teeth resemble the teeth of a snake, and in old specimens are set in several rows — in the lower jaw as many as 4, and on the front of the intermaxillary bones 5 — but in young specimens they are set in a single row in the lower jaw, and in two rows only at the extreme front of the intermaxillary bones. The pharyngeal teeth are like the jaw-teeth. On the six upper pharyngeals (three on each side) they are set in transverse rows, two rows on each bone or, in old specimens at least, three rows on each of the middle pair. On each of the lower pharyngeals, which resemble branchial arches, the teeth are set in two longitudinal rows, the outer row being composed of smaller but more numerous teeth. The gill-rakers are comparatively short and scattered, but strong and denticulated. They are set in a single row and almost exclusively on the lower part of the anterior margin of the branchial arches. On the first arch, however, which is furnished with from 7 to 9 gill-rakers, one of the latter, more like a tubercle than a spine, is sometimes set on the upper part. Even Krøyer remarked the small, denticulated splinters of bone, arranged more or less regularly in squares, that lie in the skin beside the branchial arches themselves, and render the latter rough to the touch. These splinters are usually most distinct on the outside of the lower pharyngeals. The hind (lower) part of the urohyoid bone is sharply falciform, with the point directed forward, as usual; and is almost as long as the straight anterior (upper) part of this bone. The entire bone lies free, almost half-way between the clavicular and the hyoid bones, united by muscles to the front of the lower end of the former and by a round ligament, as usual, to the under surface of the latter. The distance between its lower end, which is curved forward, and the lower end of the clavicular bone is about equal to the distance between the latter and the first ray of the ventral fin. Within its rounded angle, open in front, lies the middle part of the margin of the branchiostegal membrane, which is united from each side of the body, but with this exception free. The branchiostegal membrane and its rays — 7 on each side, the two anterior ones being partly united at the tip — conform to the usual Heterosomatous type. The gill-openings extend upwards to a level with the inferior margin of the upper eye. The operculum forms an equilateral triangle, with the upper posterior side convex and the lower posterior concave, and in this sinus lies the suboperculum, which is pointed at the top, and juts upwards almost into the dermal opercular flap. The preoperculum is rectangular, but the angular point is evenly rounded, without any distinct acuteness. The postorbital part of the head measures between about 14 and $15^1/_2$ % of the length of the body.

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[a] *Reise igiennem Island*, p. 589.

[b] *Om de nordlige Havfiskes Færd og Væsen, samt deres Fangst.*

[c] In this point Krøyer's measurements agree with ours. In Bean's specimen from Unalascha, however, the least depth of the tail was nearly $23^{1}/_{2}$ % of the greatest depth of the body.

[d] In one of Krøyer's specimens the greatest thickness of the body (just behind the eye) is stated to have been somewhat more than $^{1}/_{3}$ of its greatest depth.

The dorsal fin begins above the anterior part of the upper eye, usually in a line with the anterior margin of the pupil, in other cases somewhat in front of this point or at a distance from the tip of the snout that measures $6^1/_2$ or 7 % of the length of the body, at most [illegible] of the total length of the head, or [illegible] of the postorbital length of the head, and is always less than the length of either of the pectoral fins or than ¹/₄ of the greatest depth of the body[4]. It extends along the dorsal edge for a distance that, measured in a straight line, is equal to 72—74 % of the length of the body. In the first third of the fin the rays are of fairly uniform length, only slightly increasing in length posteriorly, and the longest rays, the length of which is 9 or 10 % of that of the body, are set at about the middle of the fin. All the anterior rays are simple; but in the posterior part of the fin the rays branch, though very irregularly — from 5 to 20 of these branched rays may be found, often scattered in the posterior part of the fin[5]. The anal fin, which in shape and structure resembles the dorsal *minus* its first third, measures from about 52 to 53¹/₂ % of the length of the body. In front of its beginning the post-abdominal bone projects in an anal spine, which in young specimens is distinct and pointed, but in older ones grows blunt and is hidden by the skin. The vent and, just behind it, the urogenital opening lie at the ventral margin itself, about half-way between the beginning of the anal fin and the insertion of the ventral fins — thus comparatively far from the former. The ventral fins are symmetrical in position, being set just in front of the perpendicular from the upper (anterior) end of the insertion of the pectoral fins. They are almost equal in length, varying in young specimens between 5¹/₂ % (on the blind side sometimes 5 %) and 6 % of the length of the body. As a rule the first two rays are simple, the others branched. The pectoral fins, on the other hand, are more dissimilar in form and length, that of the eye side being obliquely pointed and that of the blind side more evenly obtuse, and the former measuring in young females 11—12¹/₂ % of the length of the body, in young males about 13 % thereof, while the latter measures about 8¹/₂ or 9 % of the same length. In the pectoral fins too, the first (uppermost) two rays are simple — on the blind side, in most young specimens, the lowest two as well. The median length of the caudal fin is fairly equal to the length of the pectoral fin on the eye side — except in the males, where the pectoral fins are somewhat longer — as well as to the distance between the middle of its base and the end of the dorsal fin. In young specimens the hind margin of this fin is evenly concave, while in old specimens it forms a double curve or an elongated S-shape. The fin contains 13 multifid rays, and 3 supporting rays at each margin; but at least in old specimens the two longest supporting rays, the tips of which extend out to each corner of the caudal fin, are also branched.

The whole body and the head, with the exception of the fleshy lips and the nasal cavities, are covered with cycloid scales, some of them ordinary, but still small, and as usual smaller on the front part of the body than behind, and some of them still more numerous, accessory scales between the former. These accessory scales also cover the whole of the caudal fin, the outer side of the pectoral fin of the eye side, and at least the base of the ventral fin of the same side, as well as the greater part of the dorsal and anal fins. The lateral line forms a fairly high, but often irregular arch above the pectoral fin, behind the point of which it adopts a straight course almost along the middle of the sides of the body, and advances over the caudal fin, though it branches just in front of the base of this fin, one branch running straight out between the 7th and 8th or 8th and 9th branched rays[6] (counting from

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[4] In four [illegible] we have found the distance between the dorsal fin and the [illegible] to be greater than the least depth of the [illegible] [illegible].

[5] If we mark the branched rays by Roman figures, the formula for the dorsal and anal fins in five specimens is as follows:

Length of the body in millimetres	Dorsal fin	Anal fin
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

[6] At the bottom of the length of these rays it generally branches again, and follows the lower side of one of the rays and the upper side of the other, but these branches eventually join each other again. See our figure of the young Halibut (Plate XVII, fig. 1).

the dorsal edge), another between the 3rd and 4th rays, and a third between the 12th and 13th.

In their essential arrangement the internal organs resemble those of the preceding species; but the abdominal cavity is more simple, without secondary continuations in a backward direction or with only short secondary cavities to receive the ovaries. The length of the intestinal canal is also less; but a greater part of it is made up of the œsophagus and stomach, which are scarcely separated from each other externally. The stomach not only extends along the whole anterior margin of the postabdominal bone, but also turns upwards at this point from the bottom to the middle of the abdominal cavity, where the pylorus is furnished with four large and long appendages, one of them following the under surface of the stomach in a backward direction and the other three the small intestine. The liver, gall-bladder, and spleen are situated as in most Flatfishes, but they are all comparatively small. The urinary bladder, on the other hand, is large, and on each side of it lie the almost symmetrical testes or ovaries, which, as well as the urethra, open into the urogenital aperture mentioned above.

In young Halibuts (Plate XVII, fig. 1) the coloration of the eye side is light chocolate-brown, with wavy patches of a lighter shade. In some cases, the ground-colour is broken by darker, irregular, but larger patches. The blind side is white. The fins are of the same colour as the body, with waves of a darker tint, but the dorsal, anal, and caudal fins are light, shading into yellow, at the margin, and the anterior part of the dorsal fin is white or at least light, even on the eye side. In older Halibuts (Plate XVII, fig. 2) the coloration of the eye side grows darker and darker until it is almost black, the colour which we generally see in the fish-markets. v. WRIGHT has endeavoured to reproduce in his figure the slimy coat that gives this fish "a fairly bright lustre, as though it were varnished" (KRÖYER). The pupil is dark blue, and the iris yellow with a silvery lustre, but furnished, next the pupil, with a ring of a bright golden lustre.

The Halibut has a wide geographical range, and is strictly a Sub-arctic (Boreo-arctic) species, the extension of which coincides pretty closely with that of the Cod. These two species are found together on most of the large fishing-grounds in the Arctic Ocean and the north of the Atlantic and Pacific. Whether the Halibut occurs off Spitzbergen, is not yet known: but off Bear Island it is common. Even PALLAS knew that it occurred on the coast of Kola Peninsula, and was sent from there in winter to St. Petersburg in a frozen condition. He also knew of its occurrence in the Pacific, between Kamchatka and America. It is common off Iceland and is at least not rare on the coast of Greenland up to Omenak (Lat. 71° N.). According to BEAN[a] it is one of the most important fishes in the economy of the natives of Alaska, up to St. Michaels, where it attains a weight of 250 lbs. Whether it occurs along the whole north coast of America or Asia, is not yet known. On the European side of the Atlantic it seldom goes further south than Ireland and the Channel. MOREAU states, however, that it has once (in 1874) been taken off Biarritz (the south-west corner of France). On the American side, like some other Arctic species, it goes south to Cape Cod, to the end of the Arctic current: and according to BROWN-GOODE a few solitary specimens have been found off Sandy Hook. In the Pacific it is taken as far south as off Vancouver Island and conveyed thence to the fish-market of San Francisco.

On the west coast of Scandinavia the Halibut is common, at suitable spots, from the extreme north of Norway to Kullen, and in the deep channel, with from 12 to 15 fathoms of water, in the north of the Sound. Further south, south of Helsingborg, it is rare: but WINTHER saw solitary specimens caught on the north coast of Saltholm. It is no less rare in the Baltic, but solitary specimens have been met with even off Kiel. MÖBIUS and HEINCKE mention two specimens, taken in this part of the Baltic, one of which weighed 93 lbs. It has never been met with further up the Baltic.

MALM gives the following particulars of the habits of the Halibut on the coast of Bohuslän:

"The larger specimens generally live at great depths, and seldom ascend into less than 25 fathoms of water, at which depth they are taken on long-lines all the year round, but chiefly from January to April. The smaller specimens, on the other hand, often occur in much shallower water, where they are caught not so very seldom in Flounder-nets and on Haddock-lines, at depths varying between 8 and 25 fathoms. I have seen small specimens taken in the seine in 4 or 5 fathoms of water and quite close in shore." According to Collett most of the Halibuts caught in Norway are taken on the banks off the Government of Bergen, and off Nordland and Finmark. In autumn and winter these fish are said to penetrate far into the Norwegian fjords, Halibuts 6 ft. long being taken yearly off Christiania. With regard to the migrations of the Halibut in Norway even Ström[a] stated that "in winter it keeps to the very deep water off the fishing-bank of Storegg, but in summer haunts the bank itself or its edges". Off the south and west coasts of Iceland, according to Faber, the Halibut appears together with the Cod at the beginning of March, is commoner in April, and sometimes stays there the whole summer, long after the Cod has departed. To the north of Iceland it is found from May to July, and to the east from July to November. On the coast of Greenland it is taken according to Fabricius in autumn and spring, according to Rink in summer and autumn, at a depth of 20 or 30 fathoms. According to Brown-Goode observations have been made on the east coast of the United States of North America which show that the Halibut comes up in May and June into comparatively shallow water, 60 or 70 fathoms deep, but in July begins to return to greater depths. In those parts, however, it has been experienced how variable a fishery of this kind may be. "At the beginning of the present century", says Brown-Goode, "these fish were exceedingly abundant in Massachusetts Bay. From 1830 to 1850 and even later, they were very common on George's Bank; since 1850 they have partially disappeared from this region, and the fishermen have since been following them to other banks, and since 1874 out into deeper and deeper water, and the fisheries are now (1884) carried on almost exclusively in the gullies between the off-shore banks and on the outer edges of the banks in water 100 to 300 fathoms in depth." At this depth, according to Collins, the Halibut is taken all the year round, from George's Bank to the Grand Bank.

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[a] *Cat. Fish. U. S. Nat. Mus.*, Gt. Intern. Fish. Exh., London [illegible], p. [illegible]

In the Gulf of St. Lawrence, off the coasts of Newfoundland, Anticosti and Labrador, the Halibut has often been observed in shallow water and close in shore, or even at the surface, in pursuit of the Capelin (*Mallotus*). It is then very active and swift in its movements. Commonly, however, it is described as of sluggish temperament, resting at the bottom in wait for its prey. Gottsche found in its stomach Gurnard (*Trigla gurnardus*), Armed Bullhead (*Agonus cataphractus*), Whiting (*Gadus merlangus*), Cod (*Gadus callarias*), and a number of seaweeds. Others have found the stomach to contain Rays, Flounders, Turbot, Wolf-fish, Mackerel, Herrings, lobsters, crabs and large clams. Collett also found among the contents of its stomach a Black-billed Auk (*Alca torda*), a bird which dives to the bottom in fairly deep water in search of food. The Halibut is so voracious that it apparently rejects nothing that comes into its gape, which as we have mentioned, is armed with strong teeth. Even the leaden plummet of a sounding-line has shared the same fate[b]. The Halibut also takes a hook freely; and the fishery for it is carried on chiefly with this kind of tackle, in the same manner as the Cod-fishery and usually at the same time. Most of the Halibuts that are brought to market are taken on long-lines set in deep water or ordinary hand-lines. In Norwegian Finmark, according to Lilljeborg, a kind of standing hook with a float is employed. The Indians of British Columbia carry on the Halibut-fishery on the Pacific coast with primitive tackle, but none the less successfully[c]. For some reason or other they will not use steel hooks, but make their Halibut-hooks themselves of bent wood, tipped with bone. Their lines are made of seaweed, but the part nearest the hook of sinews or twisted twigs. They use clams or small fishes as bait. The fishing-season lasts from March to June. The line is trailed slowly after a canoe, with the hook in deep water. In this manner thousands of Halibuts are taken, some of which weigh more than 200 lbs., and bartered for potatoes, gammass, rush mats, and other articles[d]. The best fishing-grounds lie about twelve miles off the land; but the Halibut is also caught near the shore. Hundreds of canoes, each with a crew of two or three men, start at midnight for the fishing-ground in order to reach it in the morning. If the weather is favourable, the canoes are quite laden with fish after a half-day's fishing, and return home. If the sea grows too rough during the homeward voyage, the Indians fasten large, inflated sealskins to the sides of the canoe in order to increase its buoyancy. The hairy side of these skins is turned inward, and on the skinny side, which is turned outward, rude devices are painted, representing the sinking of a canoe, the capture of a huge fish etc. To get so large a fish as the Halibut into a canoe out at sea, is no easy task. Accidents, however, rarely happen, and it is only seldom that the fish gets away after being hooked. All goes to show that the voracity of the Halibut makes up for the rudeness of the tackle[a].

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[a] *Søndmørs Beskrivelse*, I, p. 301.

[b] "In the stomach of the Halibut," says Olafsen (*Reise Isl.*, p. 589), "all sorts of things may be found — pieces of timber from boats, rusty iron hooks, and, stranger still, though on good authority, pieces of Greenland ice of the size of one's fist. Off Oddbjörn Cliff, in 1731 at midsummer, on cutting open a large Halibut one of these pieces of ice was found, though at that season there was no ice to be found anywhere near land."

[c] See Buckland, *Nat. Hist. Brit. Fish.*, p. 178.

[d] In the same way the Norwegians of Finmark barter their fish to the Russians in exchange for flour.

According to G. v. YHLEN's notes[b], during the year 1879 58,197 lbs. of Halibut were brought to Gothenburg Fish-market, and sold at a price varying between $2^{1}/_{4}$ d. and $4^{3}/_{4}$ d. per lb. Nearly half this quantity was brought in in January, and the greater part of the rest in April, May, and March. Prices were highest in February and lowest in June. This apparently shows that the Halibut is best in winter and worst in summer, a conclusion to which we are also led by our present knowledge of its spawning in Bohuslän. On the 26th of April, 1856, MALM saw on Käringö a Halibut 131 lbs. in weight, with running roe, the total weight of which was $8^{1}/_{2}$ lbs. In the same season he examined several other Halibuts brought to the fishing-village, evidently just after they had finished spawning, and several males, $3^{3}/_{4}$—$6^{1}/_{2}$ lbs. in weight, that were either just spent, or so ready to spawn that the milt flowed out on slight pressure of the belly. Another female, which he examined on the 21st of January, 1873, 22 dcm. long and 136 kgm. in weight, had ovaries that weighed $16^{1}/_{7}$ kgm. — MALM estimated the number of the eggs at three million and a half[c] — and, to all appearances, would not have been ripe for 4 or 5 weeks to come. Thus, according to these observations, the spawning-season of the Halibut on the coast of Bohuslän lasts from the end of February to the end of April. In Iceland, according to information gained by FABER from the fishermen, the Halibut spawns from June to August. This agrees with most of the reports (BROWN-GOODE, l. c.) of the spawning-season on the east coast of North America, where it seems, however, to last at least to September, and, according to some, to begin as early as January, and thus to occupy the greater part of the year. In all probability the Halibut generally approaches comparatively shallow places to spawn, perhaps even the mouths of rivers; but nothing further is known of its spawning, nor have we any information of the development of the eggs.

There is extreme difference of opinion as to the qualities of the Halibut as an article of food. It is, no doubt, true that large Halibuts, especially after the spawning-season, are dry and lean; but smaller specimens, between 10 and 30 kgm. in weight, in winter at least are of delicious flavour, and have the advantage over many other dainties that they keep comparatively long. A Halibut hung in the open air during winter will keep fresh long enough to allow a small family to use it according to their daily requirements. The best and fattest portions are the head, especially the tongue and the hyoid region, and the bases of the dorsal and anal fins with the flesh round the interspinal and interhæmal bones. In Sweden the Halibut is eaten only when fresh — boiled or fried — but in Norway it is also salted. For many years too, it has been prepared in Norway in a manner that reminds us of the curing of stockfish. The flesh is cut into slices 2 inches broad, which are scored lengthways and across, and then hung up to dry. After some days they are ready for eating without any further preparation. The flesh of the Halibut when preserved in this manner is known as *rav* (*raff*) and *räkling*[d].

The Swedish name of the Halibut is written, pronounced, and explained in different ways. The Icelanders call it *Flydra* and *Heilag-fiske*[a] (Holy-fish). Hence, according to some, are derived both the German *Heiligbutt* and the Swedish *Helgeflundra*. Others[b] derive this Swedish name from *Helgeland* in Norway — but the Norwegians themselves generally call the species *Qveite* or *Helleflyndre*. Others again[c] write *Hälleflundra*, and derive the name from *hällar*. In Bohuslän, according to MALM, the Halibut is generally called *Hällefisk*.

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[a] Cf. also ESCHSCHOLTZ on the Halibut-fishery in Norfolk Sound, see RICHARDSON, *Fn. Bor. Amer.*, part. III, p. 256.

[b] Internationale Fischereiausstellung zu Berlin 1880, Schwed. Cat., I: Notizen über die Schwedischen Fischereien, 2; Tab. 1.

[c] BROWN-GOODE (l. c.) estimates the number of the eggs in a Halibut about 90 kgm. in weight at 2,182,773. This specimen, in which the eggs were partially ripe, was caught in September at a depth of 200 fathoms, in water of a temperature of about 36° Fahr.

[d] "The broad strips that are cut along the sides next to the back, are called *Skaare-Rav* or *Skaare-Qveite*, because they are *scored* or slit across several times in order that they may dry more quickly. The long and narrow strips cut along the sides by the fins, where the Halibut is fattest, and afterwards dried, are known by the name of *Rækling*. It is strictly the dorsal and anal fins, which are now left, but are also dried, that are called *Rav*." STRÖM, l. c.

GENUS **PLATYSOMATICHTHYS.**

Body still more elongated and fleshy than in the preceding genus. Eyes set on the right side and far apart from each other. Jaws and pharyngeals armed with pointed, for the most part straight teeth, set in two rows, with 4 large canines in the front of the inner row, on the intermaxillary bones, in a single row in the lower jaw and on the lower pharyngeals. No palatine or vomerine teeth. The dorsal fin begins behind the upper eye, which is set at the dorsal margin of the head. Hind margin of the caudal fin concave. No anal spine. Scales small and cycloid. Lateral line almost straight.

This genus also contains only one species; but its place in the system is justified partly by the narrow, single row of teeth on the lower pharyngeals and partly by its position as an intermediate form between *Hippoglossus*, *Atherestes* and *Psettodes*, which by the situation of the eyes indicates the original form common to them all. *Platysomatichthys* is the least asymmetrical of the Flatfishes, retaining the upper eye at the dorsal margin of the head and even in specimens at least 18 cm. long, only half transferred to the eye side. Both sides of the body, too, are almost equally fleshy, and the blind side is only slightly fainter in colour than the eye side.

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[a] OLAFSEN, *Reise giennem Island*, p. 358.

[b] QVENSEL, Vet.-Akad. Handl. 1806, p. 226.

[c] NILSSON, *Skand. Fn. Fisk.*, p. 634: "It is said especially to haunt those spots in deep water where springs of fresh water occur. These spots, which are discovered by the Norwegian fishermen by the common method of taking bearings (*taga met*), are known by them as *Hällir* (holes), and they believe that it is from its habit of frequenting these holes that the Halibut has received the name of *Hälleflynder*, whence the Swedish *Hälleflundra*."

THE LESSER HALIBUT (SW. LILLA HELGEFLUNDRAN).

PLATYSOMATICHTHYS HIPPOGLOSSOIDES.

Fig. 112

Greatest depth of the body in young specimens (about 18 cm. long) about 25 % of the length of the body, and in older specimens (at least 40—75 cm. long) about 26—$28^{1}/_{2}$ %[a] thereof; greatest thickness of the body about 31 % of the depth. Least depth of the tail about 29 % of the greatest depth of the body. Lateral line evenly sloping in the abdominal region. Length of the lower jaw more than half that of the head. Hind extremity of the upper jaw-bone extending in young specimens only to a line with the posterior part of the lower eye, but in old specimens beyond the perpendicular from the hind margin of this eye. The greatest depth both of the dorsal and anal fins almost coincides with the middle of the length of the body, including the caudal fin. Distance between the dorsal fin and the tip of the snout greater than the length of the pectoral fins, than $^{1}/_{10}$ of the length of the body[b], than $^{1}/_{3}$ of the greatest depth of the body[c], than $^{2}/_{5}$ of the length of the head[d], or than $^{2}/_{3}$ of the length of the head behind the eyes[e]. Length of the base of the dorsal fin only about 67—$68^{1}/_{2}$ % of the length of the body. Coloration of both sides yellowish brown[f], paler on the blind side than on the eye side.

R. br. 7; *D.* 94—96[g]; *A.* 71—76; *P.* 2 + 12[h]; *V.* 6; *C.* $x + 15 + x$; *L. lat.* por. perfor. 105 (+ 20 in pinn. caud.).

Syn. Et ugemeent Slags af Helleflyndrer, LEEM, *Beskr. Finm. Lapp.*, p. 315[i].

Pleuronectes cynoglossus, FABR., *Fn. Groenl.*, p. 163; RINK, GRÖNL., vol. I, p. 145.

Pleuronectes Hippoglossoides, WALB., *Art. Gen. Pisc.*, p. 115; GILL (*Reinhardtius*), Proc. Acad. Nat. Sc. Philad. 1861, App., p. 50; 1864, p. 218; BR. G. et BEAN (*Platysomatichthys*), Bull. Ess. Inst., vol. XI, p. 7; COLL., Norsk. Nordh. Exped., Zool., Fiske, p. 142; JORD., GILB., Bull. U. S. Nat. Mus., No. 16, p. 819; COLL., N. Mag. Naturv. Christ., Bd 29, p. 98; LILLJ. (*Hippoglossus*), *Sv., Norg. Fn., Fisk.*, vol. 2, p. 295; COLLINS (*Platysomatichthys*), Bull. U. S. Fish. Comm., vol. V (1885), p. 256.

Pleuronectes pinguis, FABR., Dansk. Vid. Selsk. Naturv., Math. Afh., vol. I (1824), p. 45; REINH. (*Hippoglossus*), ibid., vol. VII, p. 116; KR., *Voy. Scand.*, cett. (GAIM.), tab. 22; BLKR (*Platysomatichthys*), Versl., Mededeel. Akad. Weten., Afd. Naturk., 1862, p. 426; STEENSTR., Overs. D. Vid. Selsk. Forh. 1863, p. 186; ESM. (*Hippoglossus*), Forh. Skand. Naturf. M. Christ., 1868, p. 526; COLL., Forh. Vid. Selsk. Christ. 1874, Tillægsh., p. 135; ibid. 1879, No. 1, p. 74; LTKN, *Fish. Groenl.*, Arct. Man. 1875 (Comm. Roy. Soc.), p. 120.

Hippoglossus grœnlandicus, GTHR, *Brit. Mus. Cat., Fish.*, vol. IV, p. 404.

The Lesser Halibut has been known within the limits of the Scandinavian fauna for more than a century[j] (since 1767), but it is still one of the rarities in our museums. It is also a deep-sea fish for which no special fishery is carried on in Scandinavia, though in recent years it has been caught so often on the coast of Norwegian Finmark, that COLLETT declares that in those parts it "is not particularly rare." It is far more common on the coast of Greenland, where it has been for many years the object of an important fishery. It never attains so large a size as the preceding species: according to FABRICIUS its length on the coast of Greenland scarcely exceeds $26^{3}/_{4}$ in. (68 cm.). The largest specimen COLLETT ever saw, was caught off Vardö, and measured 92 cm. in length. COLLINS, who (l. c.) has published Captain JOHNSON's notes of a fishing-voyage in 1885 to the edges of the deep-water pocket on the eastern side of the Grand Banks (44° 3′ N. lat.), states that there the average weight of the Lesser Halibut is between 5 and 10 lbs., but that on this voyage some extraordinarily large specimens were taken, weighing on an average more than 20 lbs.

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[a] According to LILLJEBORG about 31.

[b] About $11^{1}/_{2}$—$10^{1}/_{2}$ % thereof, according to the specimens before us.

[c] About $44^{1}/_{2}$—$36^{1}/_{2}$ % thereof.

[d] About $46^{1}/_{2}$—42 % thereof.

[e] About 83—68 % thereof.

[f] According to FABRICIUS (*Fn. Groenl.*) brownish gray (*fuscocinereus*) or (1824, l. c.) light gray.

[g] *D.* 92—102, according to COLLETT.

[h] *P.* 14—15, according to COLLETT.

[i] "Juxta insulam *Bug-Oen*, in Finmarchia orientali, Passeres occurrunt, in eo a ceteris sui generis discrepantes, quod non per dorsum dumtaxat, sed etiam sub ventre, adeoque toti, nigri sint, et tam pinguedine, quam sapore illis multum præstent."

[j] Nearer 200 years, according to COLLETT, who gives a reference to "Lillienskiold's great work *Speculum boreale*, published in 1698," where the same remark is said to occur as that just quoted from LEEM. The work is unknown to us.

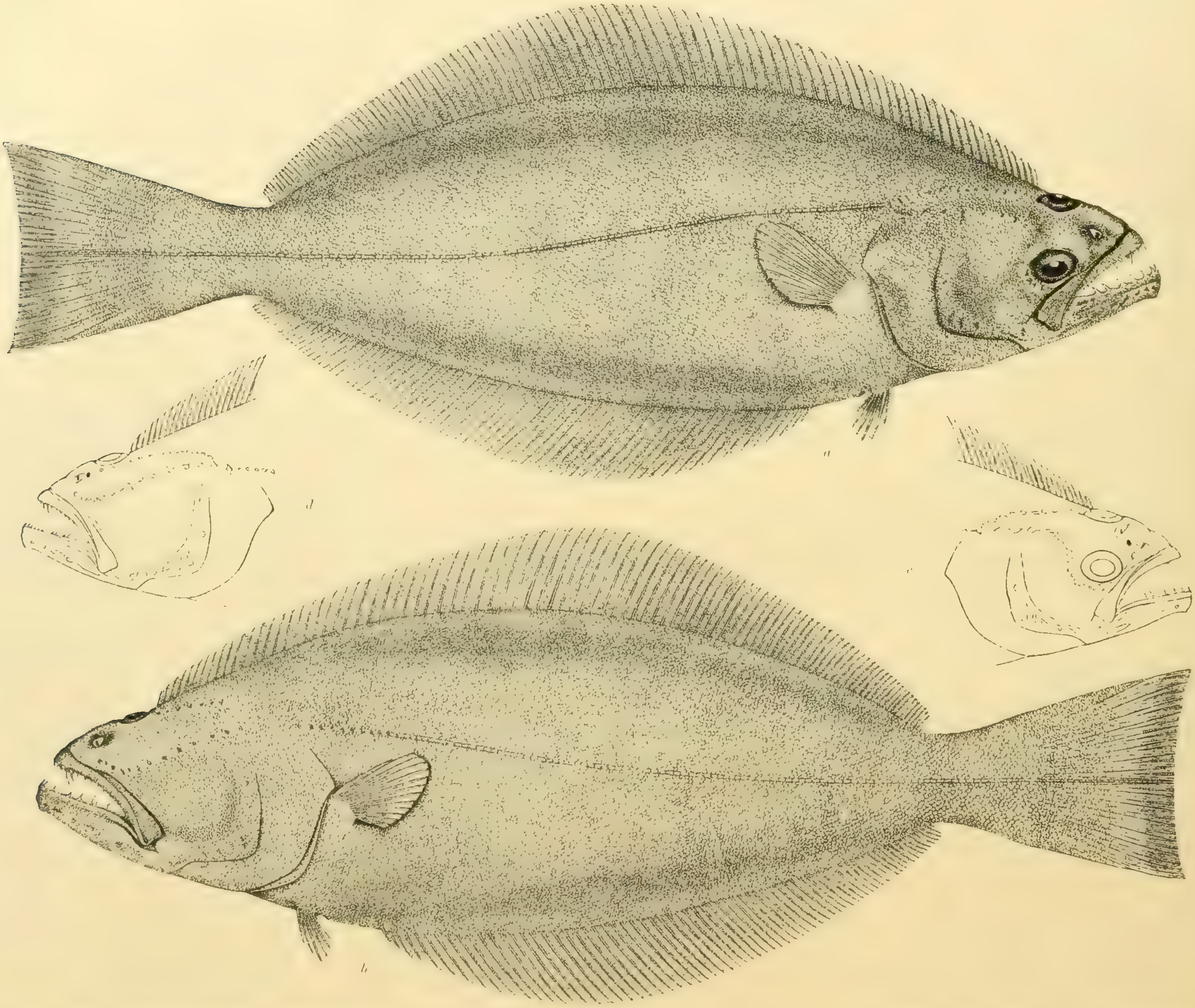

Fig. 112. *Platysomatichthys hippoglossoides* from Greenland. *a* (eye side) and *b* (blind side) $^1/_2$ the natural size, drawn from a specimen in the Zoological Museum of Copenhagen University; *c* (eye side of the head) and *d* (blind side of the head) natural size, drawn from a specimen taken at Godhavn by Captain Amundsen.

In all the characters, except those given above — almost all of which may be interpreted as expressions of a lower degree of development and less advanced asymmetry — the Lesser Halibut is so like the preceding species that no detailed description is necessary, as we are enabled to refer to our carefully-drawn figures. The larger size of the mouth and the comparatively greater strength of the jaw-teeth, though they are more scattered, suggest that the Lesser Halibut is still more voracious than its near relative; and to this is due, in all probability, its reputation for fatness.

This supposition is borne out by the descriptions of both Fabricius and Rink. "The Lesser Halibut, *Kalleraglik*," says the latter, "is distinguished by its occurrence in deep-water, and is taken almost exclusively in the ice-fjords, or at spots where large icebergs drift past or where they continually run aground. Furthermore it is caught only during the coldest months of the year. This species has been observed in many places widely removed from each other, on occasions when solitary specimens have been taken, or when they have been seen at the surface in flight from the Greenland seal, in the stomach of which specimens have been found, or from the white whale (*Delphinapterus leucas*). However, the Lesser Halibut is now (1857) taken almost exclusively in two places, the ice-fjord of Jakobshavn and Omenak Fjord, and in each of these inlets on certain banks alone. In Jakobshavn Fjord these banks lie within the opening and within the shallows which are continually occupied by the very largest icebergs; but there is another fishing-bank, which is, however, in less repute, outside the opening. In the month of January the Esquimaux cut holes at certain spots in the ice, and fish with hook and line at a depth of 350, or even, it is asserted, 380 fathoms. The line is generally made of thin twine or, still better, of whalebone, for with a line of this material it is easier to feel the bite, and thus much time is spared which would be lost if the fisherman were doubtful whether he had a bite or no. The most important point on which the success of this fishery depends, lies in the different positions taken by the icebergs before they are ice-bound and the fjord freezes. Sometimes large icebergs collect on the banks or round them, and thus render the fishery quite impossible or very dangerous, as the icebergs "*calve*" (split into smaller pieces)[a], and the fisherman is compelled to stay close to them for long periods during the fishery. The Esquimaux are incredibly skilful in making their way along this treacherous fjord, the opening of which, on account of the large bank covered with icebergs, is of the same character as the innermost parts of other ice-fjords, at the verge of the solid land-ice. Thus, in 1851, a most unfavourable year to the Halibut-fishery, the Esquimaux might be seen, surrounded half by open water and half by icebergs, on ice that was partly broken up by the "calving" of the icebergs and partly worn away by the current, and at spots which it seemed physically impossible for a human foot to reach. In addition to the difficulties thrown in the way of the Halibut-fishery by the icebergs, it is also supposed that the Halibuts are driven away by white whales (*Delphinapterus leucas*), and it is not much use fishing as long as these dolphins rove in the open water outside the opening of the fjord. When the circumstances are favourable, one person may catch 10 Halibuts a day on an average or, in exceptionally fortunate cases, 18, and the fishery may begin in January and go on to the middle of March; but in other years it hardly lasts a week, and its average duration is probably hardly more than a month. In unfavourable seasons hardly more than 2—4 fish are taken daily on each line. On the other side of the ice-fjord, off Claushavn, the fishery is carried on in exactly the same way; but scarcely more than 20 fishermen are engaged at the same time. The Halibuts weigh on an average between 5 and 6 kgm. and seldom more than 10 kgm. They are very fat and are much liked by the Esquimaux. They are also very well adapted for purposes of curing when cut into slices and dried. On account of their great fatness they yield excellent train-oil. When the catch of seals is scanty, the Halibut can thus supply not only food but also the most necessary article for purposes of domestic warming and lighting. In Omenak Fjord the species is found on numerous banks, scattered about at some distance from each other. Every inhabited place has one or more banks at a distance of less than 3 miles if we except the outermost part of the fjord, off Niakornak, where the banks are very few. In Omenak Fjord the depth of the water fished is only slightly more than 200 fathoms; and here the fisherman is less exposed to the danger of the banks' being covered by icebergs. But in this fjord the Halibuts are smaller and less plentiful than in the ice-fjord of Jakobshavn."

On the American side of the Atlantic the range of the Lesser Halibut thus extends, as far as we know, from Omenak to Cape Cod (between Lats. 71° and 42° N.); on the east side of the Atlantic is seems to go farther north, at least to about the 73rd degree of latitude[b], but not so far south, perhaps not much south of the 70th degree of latitude. Its bathymetric extension is between about 60 and 450 fathoms.

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[a] Cf. the expression to "cave in."

[b] The Norwegian Arctic Expedition found it at a depth of 447 fathoms, in lat. 72° 57' N., long. 14° 32' E. The bottom was composed of gray clay, and the temperature at the bottom was 30·56° Fahr.

Genus DREPANOPSETTA.

Body of the ordinary Platessoid form. Eyes set usually on the right side, and even in adult specimens fairly close to each other. Jaw-teeth pointed and generally set in a single row in both jaws[a]. *Lower pharyngeal teeth also pointed, set in two rows or*[b] *one. No palatine or vomerine teeth. The dorsal fin begins above or a little in front of the upper eye. Hind margin of the caudal fin convex. Anal spine present. Scales middle-sized and ctenoid. Lateral line almost straight.*

This genus is very closely related to another, *Paralichthys* (*Pseudorhombus*), which contains more numerous species, and from which it is distinguished chiefly by its straighter lateral line and by the eyes' being usually set on the right side. Its geographical extension is Subarctic, chiefly confined to the Pacific, where four species are known. Only one species, of which two distinct varieties occur, belongs to the basin of the Atlantic.

With regard to the generic name it is true that most recent writers have accepted *Hippoglossoides*, the name proposed in 1835[c] by GOTTSCHE. But besides the fact that the formation of this name, as MALMGREN has already observed[d], is contrary to the Linnæan rule that "*nomina generica in* **oides** *desinentia e foro historiæ naturalis releganda sunt*"[e], it is proposed by GOTTSCHE merely to denote a division of CUVIER's subgenus *Hippoglossus*. If we should insist, however, upon the retention of this name, and also strictly follow the current rules of nomenclature, the family of the Halibuts, as it is represented in the Scandinavian fauna, would appear as follows:

Hippoglossus hippoglossus, LINN.,
Hippoglossus (*Platysomatichthys*) *hippoglossoides*, WALB.,
Hippoglossoides platessoides, FABR.,

an arrangement no less tautological than confusing. In this case, therefore, we are fully justified in rejecting the generic name of *Hippoglossoides* and adopting *Drepanopsetta*, the name proposed by GILL[f], although GILL himself subsequently[g] withdrew this proposal.

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[a] Or also, in certain exotic species, an inner row of small teeth on the intermaxillary bones.

[b] According to the observations of others.

[c] Wiegm. Arch. f. Naturg., 1 Jahrg., 2 Bd., p. 164.

[d] Öfvers. Vet.-Akad. Förh. 1864, p. 256.

[e] LINNÆUS, *Philos. botan.*, p. 161, § 226.

[f] Proc. Acad. Nat. Sc., Phil. 1861, App., p. 50.

[g] Ibid., 1864, p. 217.

THE ROUGH DAB (SW. LERFLUNDRAN).

DREPANOPSETTA PLATESSOIDES.

Plate XVII, fig. 3.

Jaw-teeth set in a single row both in the upper and the lower jaw. Branchiostegal rays 8. Gill-rakers on the first branchial arch at most 15. Length of the branch of the lower jaw on the blind side more, on the eye side usually less, than half the length of the head. Scales of the body firmly attached, on the eye side extending over all the fin-rays and in front, at least partly, over the jaw-bones. Lateral line without dorsal branch in a backward direction. Total length of the head varying between 20 and 23 %[a] of the length of the body, its postorbital length between about 12 and 14 %[b] thereof. Coloration of the eye side grayish brown with a dash of red, spotted with dark brown; blind side bluish white.

R. br. 8; *D.* 76—93[c]; *A.* 64—73[d]; *P.* 10—13[e]; *V.* 6; *C.* x + 12 l. 14 + x.; *Lin. lat.* 85—102 (+ 20—25 in pinn. caudali); *Vert.* 45 l. 46.

a: Forma *platessoides*, americana: altitud. max. corporis $> {}^{35}/_{100}$ longit. ejusdem; altitud. minim. corporis $> {}^{3}/_{4}$ longit. mandib. in latere oculari. Num. rad. pinn. pector. 12 l. 13.

Syn. *Pleuronectes platessoides*, FABR., *Fn. Groenl.*, p. 164; D. Vid. Selsk. Naturv., Math. Afh., vol. I, p. 50; REINH. (*Citharus*; nom. gen. antea usurp.), ibid., vol. VII, p. 130; KR., *Voy. Scand.*, cett. (GAIM.), tab. 21; GILL (*Drepanopsetta*), Proc. Acad. Nat. Sc. Philad. 1861, App., p. 50; (*Hippoglossoides*), ibid. 1864, p. 217; BR. GOODE, Proc. U. S. Nat. Mus., vol. 3 (1880), p. 471; JORD., GILB., Bull. U. S. Nat. Mus., No. 16, p. 826.

Hippoglossoides limandoides, GOODE et BEAN, Amer. Journ. Sc., Arts., vol. XVII (1879), p. 39.

b: Forma *limandoides*, palæarctica; altitud. max. corporis $< {}^{35}/_{100}$ longit. ejusdem; altitud. minim. corporis $< {}^{72}/_{100}$ longit. mandib. in latere oculari. Num. rad. pinn. pector. $<$ 12.

Syn. *Pleuronectes linguatula*, PONTOPP., *Dansk Atl.* I, p. 649, tab. 27; MÜLL., *Zool. Dan. Prodr.*, p. 45, No. 377; RETZ., *Fn. Suec.*, *Lin.*, p. 332; — nec *Pl. linguatula* LINNÆI, quæ species ex ART. et WILLUGHB. = *Citharus linguatula* auctt., in mari Mediterraneo; vide FRIES, Vet.-Akad. Handl. 1838, p. 179.

Pleuronectes limandoides, BL., *Ausl. Fisch.*, part. III, p. 24, tab. CLXXXVI; QVENS., Vet.-Akad. Handl. 1806, pp. 54 et 222; FAB., Tidskr. Naturv., V (1828), p. 244 et Isis, 1828, p. 878; NILSS., *Prodr. Ichth. Scand.*, p. 57; SCHAGERSTR., Physiogr. Sällsk. Tidskr., p. 312; PARN. (*Platessa*), Wern. Mem., vol. VII, p. 368, tab. XXXVIII; SUND. et v. WRIGHT (*Pleuronectes*), *Skand. Fisk.*, ed. I, p. 117, tab. 27; KR. (*Platessa*), *Danm. Fiske*, vol. II, p. 358 et vol. I, p. 611; NILSS. (*Pleuronectes*), *Skand. Fn.*, *Fisk.*, p. 629; GTHR (*Hippoglossoides*), *Cat. Brit. Mus.*, *Fish.*, vol. IV, p. 405; COLL., Forh. Vid. Selsk. Christ. 1874, Tillægsh., p. 136; MALM. *Gbgs. Boh. Fn.*, p. 509; WINTH., Naturh. Tidskr. Kbhvn, ser. 3, vol. XII, p. 37; DAY, *Fish. Gt. Brit.*, *Irel.*, vol. II, p. 9, tab. XCV; MÖB., HCKE, *Fisch. Osts.*, p. 88.

Hippoglossus (*Hippoglossoides*) *Limanda*, GOTTSCHE, Arch. Naturg., Jahrg. I, Bd. 2 (1835), p. 168.

Drepanopsetta platessoides, MALMGR., Öfvers. Vet.-Akad. Förh. 1864, p. 525; COLL. (*Hippoglossoides*), Forh. Vid. Selsk. Christ. 1878, No. 14, p. 92; ibid. 1879, No. 1, p. 74; Norsk. Nordh. Exped., Zool., Fiske, p. 114; LILLJ., *Sv.*, *Norg. Fn.*, *Fisk.*, vol. II, p. 299.

Obs. In recent times it has been the general practice to follow COLLETT's example and identify the Greenland and North American *Drepanopsetta platessoides* with the European *Drep. limandoides;* and it cannot be disputed that the difference between them is only slight. Even in his *Catalogue* (l. c.) GÜNTHER suspected that these two species were identical. However, he could not defend his opinion by personally comparing American and European specimens. Now, on making such a comparison — though we have had only three American specimens, one male and two females — we find the differences between them far too important to admit of our unhesitating assent to the identification of the two species. It is true, as COLLETT has pointed out, that in the European form the number of rays in the dorsal and anal fins is so inconstant that, as a rule, the specimens that live in the far north have more rays in these fins than the inhabitants of more southern regions. Whether this rule also applies to the American form, is as yet unknown; but in the specimens of the Royal Museum we find at least one exception. In a specimen (♀) taken at Ivigtut by the Sofia Expedition in 1883 the formula is *D.* 93, *A.* 73, while in a specimen (♀) taken off Holsteinborg by Dr. ÖBERG it is *D.* 80, *A.* 67. Hence we see that, even within the limits of the Arctic fauna, the variation may be considerable. COLLETT has also given sufficient evidence to show that the number of these rays is untenable as a specific character. On the other hand, to judge by many other species, it seems probable that the difference shown by the specimens of the Royal Museum in the number of rays in the pectoral fins, is more constant. To this we may add the deeper form of the body which is characteristic of the American form, and which, in spite of the variations that accompany the usual changes of growth and the difference of sex, cannot be regarded as entirely wanting in significance. As a rule, in *Drepanopsetta platessoides*, the greatest depth of the body is more, in *Drep. limandoides* less, than 35 % of the length of the body; and in consequence, the length of the head in the former is less than 63 %, in the latter more than 64 %[a], the posterbital length of the head in the former less, in the latter more, than $37 \frac{1}{2}$ %, and the length of the branch of the lower jaw on the eye side in the former less than 28 %, in the latter more than 30 % — all in proportion to the greatest depth of the body. The same relation is also expressed by the fact that the least depth of the body (across the peduncle of the tail) in *Drep. platessoides* is more than 75 %, in *Drep. limandoides* less than 72 %, of the length of the branch of the lower jaw on the eye side. Another character which also seems to be constant in adult specimens, lies in the fact that the greatest thickness of the body in *Drep. platessoides* is more, in *Drep. limandoides* less, than $\frac{2}{3}$ of the length of this branch of the lower jaw. We have here to consider the same question as we have just discussed with reference to the distinction between *Pleuronectes glacialis* and *Pl. cicatricosus*. It may indeed be true that during youth these forms cannot be distinguished — in any case we have not sufficient knowledge of their early stages to decide. But during the latter part of their development they are distinctly separated, and, strange to say, the difference between *Drep. platessoides* and *Drep. limandoides* runs parallel to that between *Pleur. glacialis* and *Pleur. cicatricosus*, just as the latter difference has proved above to be parallel to that between *Pleur. platessa* and *Pleur. flesus*. In all three cases the differentiation of form has taken the same course. In the Plaice and the Flounder it has indeed advanced further, but not even these species have escaped the suspicion of being "links in a common series of forms, made up of the finest shades of difference."

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[a] Between 20·3 and 23·0 % in the specimens which we have examined, and which were between 228 and 396 mm. in length. According to COLLETT this proportion sometimes exceeds 24 or even 25 %, a character which otherwise belongs to the fry.

[b] Between 11·9 and 14·1 in the specimens which we have examined.

[c] Sometimes as many as 101, according to COLLETT.

[d] Sometimes as many as 79, according to COLLETT.

[e] On the blind side sometimes 9.

The following table shows partly the most important changes of growth in *Drepanopsetta limandoides* as it increases in length from 228 to 315 mm., and partly the relation of this form (on an average) to *Drep. platessoides* while between 310 and 396 mm. in length:

	Average			Measurements of a ♂ specimen of *Drep. platessoides* from Halifax	Obs.
	Drepanopsetta limandoides		3 specimens (♂ + ♀ ♀) of *Drep. platessoides.*		
	3 specimens (♀ ♀ ♀).	3 specimens (♀ ♀ ♀)			
Length of the body, expressed in millimetres	242.2	294	341.7	319	
Total length of the head in % of the length of the body	21.7	22.0	21.1	22.0	juv. < sen. ♀ < ♂
Posterbital length of the head	12.9	13.3	12.7	13.1	juv. < sen. ♀ [illegible] ♂
Greatest depth of the body	32.1	31.6	37.0	35.4	♀ [illegible] ♂
Least depth of the body	7.1	7.3	8.0	7.5	♀ [illegible] ♂
Length of the branch of the lower jaw on the blind side	11.8	12.7	11.6	11.9	juv. [illegible] sen. ♀ < ♂
Length of the branch of the lower jaw on the eye side	10.3	10.9	9.9	9.9	juv. [illegible] sen.
Distance between the dorsal fin and the tip of the snout	6.9	6.0	5.7	6.0	♀ [illegible] ♂
Length (base) of the dorsal fin	70.5	70.5	73.1	72.9	♀ [illegible] ♂
Height (longest ray) of the dorsal fin	9.1	9.0	9.4	10.9	juv. [illegible] sen.
Distance between the anal fin and the tip of the snout	29.0	27.8	29.0	27.2	juv. [illegible] sen. ♀ > ♂
Length (base) of the anal fin	52.8	53.0	57.3	56.7	♀ [illegible] ♂
Height (longest ray) of the anal fin	9.3	9.4	9.2	10.9	juv. [illegible] sen.
Length of the pectoral fin on the eye side	10.8	9.1	10.7	12.2	juv. [illegible] sen.
Length of the pectoral fin on the blind side	8.1	7.5	8.0	9.7	juv. [illegible] sen.
Length of the ventral fin on the eye side	7.3	7.8	7.8[b]	8.8	juv. [illegible] sen. ♀ [illegible] ♂
Length of the ventral fin on the blind side	8.0	8.4	8.5[b]	9.4	juv. [illegible] sen. ♀ > ♂
Length of the caudal fin at the middle	15.2	16.8	15.1	15.7	juv. [illegible] sen. ♀ [illegible] ♂
Total length of the head in % of the greatest depth of the body	67.6	69.9	57.1	62.2	juv. [illegible] sen. ♀ < ♂
Posterbital length of the head	40.2	42.2	34.6	37.1	juv. [illegible] sen. ♀ [illegible] ♂
Least depth of the body in % of the length of the branch of the lower jaw on the eye side	69.7	66.7	80.6	76.2	juv. [illegible] sen. ♀ [illegible] ♂
Greatest thickness of the body	61.7	59.9	70.1	69.8	juv. [illegible] sen. ♀ [illegible] ♂

The table shows distinctly that in hardly a single one of the average relations does *Drepanopsetta platessoidés* fit exactly into the series of the changes of growth. In some cases the series is broken by the average measurement of this form, which in these respects represents the characters both of the young specimens and the females; while in others the series does indeed run in the same direction, rising or falling in all three of the first columns, but is irregular, with too wide or too narrow a gap between the second and third columns, this being due to the fact that the characters of a male specimen have been included in the third column of averages.

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[a] The minimum proportion in this respect in all the specimens examined by COLLETT was 65 %.

[b] In its capacity of a change of growth this relation is less than would have been the result of a uniform course of development.

while only female characters are given in the other two. If we eliminate this disturbing influence from the comparison, the result becomes still clearer: *Drepanopsetta platessoides* represents the highest stage of development of the female characters.

If we now compare this table with that given above (p. 107), which shows the relation between the four forms of the Plaice group, we find that, in 12 of the 16 relations there given, as soon as the percentage is greater in *Pleur. glacialis* than in *Pleur. cicatricosus*, or when the percentage is greater in *Pleur. platessa* than in *Pleur. flesus*, the percentage in *Drepanopsetta platessoides* is also greater than in *Drepan. limandoides*, while, when the percentages run in the opposite direction, the case is reversed. Again, just as *Pleuronectes glacialis* is a more strictly Arctic form than *Pleur. cicatricosus*, so also *Drepanopsetta platessoides*, as being a Greenland form the southward range of which is bounded by the southern termination of the Arctic current that follows the east coast of North America, may be regarded as a more Arctic form than *Drepanopsetta limandoides*, which, it is true, goes as far north as Spitzbergen, but is also found at least as far south as the south-west point of England, where no current can explain the occurrence of Arctic forms. Thus, the original form of this group, too, has probably belonged to the Arctic fauna.

With these reservations, and until a more extensive supply of materials for examination may perhaps put this question in another light, we adopt the opinion first hazarded by GÜNTHER and subsequently more deliberately weighed by COLLETT, that both these forms may be included under a common specific name. Among the synonyms of the species BROWN-GOODE and BEAN also give STORER's *Platessa dentata*, though he states (Mem. Amer. Acad. Arts., Sci., n. ser., vol. VIII, part. II, p. 391) that in its case the dorsal fin begins *just over the middle of the eye*, an expression which, if we adopt the synonym, must not be taken too literally.

On the coast of Scandinavia the average length of the Rough Dab is 22—25 cm., though it is sometimes 29—32 or even 35 cm.[a] long. Apart from its large mouth, the species shows a general resemblance to the Dab (*Pl. limanda*); and it is from this that the name of *limandoides* is derived. In the form which occurs in Scandinavian waters the greatest depth of the body is about $^1/_3$ of the total length, and the greatest thickness about $^1/_4$ of the greatest depth. The length of the head measures about $^1/_4$ (26 %) of the length of the body to the base of the caudal fin. The dorsal edge of the head slopes evenly downwards from the beginning of the back. The eyes are exactly the same in form and structure as in most of the Flounders; they are almost equal in size and are set on the right side, the upper scarcely $^1/_5$ of its length behind the lower. The length of the latter is in young specimens somewhat greater than, in old about equal to, the distance between it and the tip of the snout; and its hind margin lies at about the end of the second fifth of the head. The inner side of each eye (the side nearest the other eye) is somewhat more raised than in most Flatfishes, the position of the iris being thus more nearly vertical, and the pupils being turned in opposite directions. This is a similar arrangement to that which enables the Flatfishes in general to see both to the right side and the left without any special exertion, when they are lying with the blind side on the bottom, and which is supplemented by the great mobility of the eyes. In this species the interorbital space forms a narrow carina, somewhat higher than usual, which, in spite of this, disappears as we follow it backwards. The nostrils of each pair are distinctly separated from each other. On the eye side the anterior nostril, which is obliquely raised into a tubular form, lies just at the edge of the cheek-fold (the lower margin of the preorbital bone) above the maxillary bone, while the posterior, which is without raised margin, is situated somewhat higher up than the anterior, almost in the line drawn between the anterior margins of the eyes, but nearer to the lower eye than to the upper. The nostrils of the blind side, which in other respects resemble those of the eye side, lie somewhat nearer each other, in a straight line with the base of the dorsal fin, the anterior being situated about half-way between the lower margin of the preorbital fold and the beginning of the dorsal fin, or somewhat nearer the former. The mouth is fairly large, this being the most striking difference between this species and the true Flounders; and the upper jaw-bone is so long that, if bent upwards above the lower eye, it would extend to the hind margin of the latter. The teeth are conical and pointed, especially on the intermaxillary bones; small, but in front, especially on the intermaxillary bone of the eye side, larger; and arranged in a single, rather irregular row, at intervals about equal to the breadth of a tooth. On the eye side they are recurved and behind smaller, but are present along both jaws, except in the hindmost part of the lower jaw. In this species as in most of the Flatfishes, the two transverse dermal folds (palatal curtains) within the rows of teeth, both in the upper jaw and the lower, are broad and resemble true vela[b]. The gill-cover is free, as usual, above the pectoral fin and across the posterior opercular corner. The margin of the branchiostegal membrane is not folded back so far as in most of the Scandinavian Flatfishes. This is the only Scandinavian species of the Flounder-series that has 8 branchiostegal rays, 7 large and somewhat flattened rays on each side and a pair of smaller ones, set close together. at the middle.

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[a] On the English coast, according to DAY, a specimen 38 cm. long has been found.

[b] For the function of these folds, see above, p. 263.

In the European form the dorsal fin generally contains between 78 and 87 or 88 rays. It is highest at the middle ($^1/_4$ to $^1/_3$ of the greatest depth of the body) and gradually decreases in height towards the ends, all the rays being simple. It begins somewhat over on the blind side, some distance at least in front of the middle of the eyes. Its rays curve, when depressed, towards the blind side, and as in the preceding species with the exception of the Sole the posterior rays show a decided tendency to lie in a forward direction. The anal fin begins a little behind the vent, just below the hind (lower) end of the base of the pectoral fin, and is as usual analogous to the dorsal fin in shape and in its backward extension. In the European form it contains 64—66 (exceptionally 60 or 68) simple rays. The hind margin of the caudal fin forms an obtuse but distinct, projecting angle at the middle. This fin contains 18 rays, 3 or 2 simple ones above and below[a], and the latter rays are always considerably shorter than the others. The remaining 12 (or 14) rays are only once branched, and as in all the Scandinavian Flatfishes except the Halibut, are not capable of any considerable expansion. In the European form the pectoral fin of the eye side contains 10 or 11 rays, all, or at least the outer ones, simple. In the latter case the middle rays are only very indistinctly branched at the tip. The pectoral fin of the blind side contains 9 or 10 rays, also simple, or still more indistinctly branched than the rays of the corresponding fin on the eye side. We may find either 10 rays on both sides or 11 on one side and 10 or 8 on the other. On the eye side the length of the fin is about equal to, or in old females slightly less than, half the length of the head, and the 2nd or the 3rd ray is the longest; on the blind side the fin is considerably shorter, and the 5th and 6th rays are the longest. The ventral fin of the blind side is generally somewhat, though only slightly, longer than that of the eye side. In form the two ventral fins are alike, being rounded and containing 6 simple rays, the 4th and 5th rays being the longest. They are inserted just in front of the perpendicular from the anterior end of the base of the pectoral fins. The tips extend to the beginning of the anal fin or a little further back. The vent lies about half-way between the insertions of the ventral fins and the beginning of the anal fin, exactly at the ventral edge, but with a small anal papilla, curved obliquely backward towards the eye side. The anal spine projects forward, as usual, from the beginning of the anal fin.

The scaly covering of the body is abundant, most closely resembling that of the Dab. In this species, however, the scales are more uniform in size — though they are, as usual, somewhat larger on the hind part of the body and smallest on the head — and, therefore, arranged in more regular rows. At the middle of the body about 30 scales may be counted in an oblique row from the lateral line to the dorsal fin and about 32—40 in a similar row to the anal fin. The scales are almost circular. The free (hind) margin is marked with two small notches, which leave a rounded, obtuse projection between them, and is set along the whole breadth of the scale with from 12 to 20 or more, fine, subulate spines, which diverge slightly from each other, and render the scales rather rough to the touch when stroked the wrong way. On the blind side, however, most of the scales are smooth, ctenoid scales occurring only on the hind part of the body and at the bases of the fins. On the eye side of the head only the nasal cavity, the tip of the snout, and the intermaxillary bones (and, of course, the eyes) are naked; but the carina between the eyes, as well as its continuation in front of them, the broad hind part of the maxillary bone, and at least the hind part of the branch of the lower jaw are furnished with small, spiny scales. On the blind side of the head, however, the maxillary bone, the lower jaw, and the preoperculum are also scaleless. All the fins on the eye side, as well as the blind side of the caudal fin, are generally furnished with two rows of scales on each ray; but in this respect there is considerable variation, the rule applying only to the middle parts of the fins. The lateral line is more than usually distinct and throughout the greater part of its course quite straight, though its first quarter forms a slight upward curve on the abdominal region. The lateral line advances over the caudal fin along the lower margin of the sixth branched ray, or the ninth, if we reckon the upper supporting rays as well.

The coloration of the right or eye side of the Rough Dab is an almost uniform grayish brown, more or less dark, and generally strewn with scattered, indistinct, darker spots. When the fish has been some time out of the water, the colour fades, and in the fish-markets we generally find this species of a light gray. The blind side is, as usual, white or bluish white.

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[a] In all our specimens of the European form the number of these simple rays is 3 above and 3 below; in a specimen of the American form we find only 4 of these supporting rays, as the inner (hindmost) of them, above and below, is branched like the true caudal rays.

The Rough Dab is fairly common throughout the Cattegat, but is not taken in large numbers. It often enters the Sound, and, according to MÖBIUS and HEINCKE, is of annual occurrence off Kiel, though it has never yet been found in the Baltic proper or even on the south coast of Scania. From the north of the Sound and the vicinity of Kullen it is brought every spring with other Flatfishes and exposed for sale in the market-place of Lund. On the coast of Jutland, according to FABER[a], it is more common, but in the island-belt of Bohuslän it is not taken very often. At Landskrona, according to SCHAGERSTRÖM, it is called *Horntunga*; at Kullen, according to NILSSON, *Judepiga* (Jutland-maid), or *Stormun* (Big-mouth); on the coast of Jutland, according to FABER, *Haa-ising* (Sea-flounder) or *Skjær-ising* (Rock-flounder), and in other parts of Denmark, according to GOTTSCHE, *Mareflynder* (Sea-flounder), *Tungens hoer-unge* (Bastard Sole), *Uægte tunge* (= the preceding name), *Jydetunge* (Jutland Sole) and *Jydekjærling* (Jutland-hag). In Bohuslän it is often called *Såla* (Sole) or, according to MALM, *Storgap* (Big-mouth), *Glib* and *Glibskädda*, or is confused with *Pleuronectes limanda* under the name of *Sandskädda*. Near Christiania LILLJEBORG heard it called *Engelsman* (Englishman). The geographical range of the species also embraces the whole of the North Sea and the north of the Atlantic up to the Arctic Ocean. It has never been found in the White Sea or further eastwards. To the south it grows rare even on the south coasts of Ireland and England, though, according to DAY, numerous specimens are sometimes met with, as for instance in the summer of 1880, off Brixham. On the French coast it has never been found.

Like the Dab, the Rough Dab is said generally to inhabit deeper water than the most common Scandinavian Flatfishes (the Plaice and the Flounder), but scarcely anything more is known of its habits. In Bohuslän, according to MALM, it is taken "at a depth of from 12 to 20 fathoms and generally on a clean sandy bottom" (though KRØYER states that off Hirsholm it prefers a muddy bottom) or sometimes "in seines, which are shot at a depth of 5 or 6 fathoms and hauled up on shore." In winter, according to SUNDEVALL, it retires to a depth of 30 fathoms.

The spawning-season of the Rough Dab was supposed by SUNDEVALL, and subsequently by COUCH, to take place at the beginning of summer (May or June), an hypothesis which agrees with NILSSON's more recent statement that at Kullen it is best in April and up to the middle of May. KRØYER, on the other hand, found Rough Dabs in September with the ovaries so well-developed that he assumed the spawning-season to occur in the middle of winter, while MALM quotes a statement of the fishermen of Bohuslän to the effect that "the roe runs in February and is spent by the month of March." We have no more trustworthy observations to rely on.

The food of the Rough Dab is composed of crustaceans, shellfish, starfish and small fishes. In its stomach and intestine KRØYER often found *Gobius minutus*, SUNDEVALL shrimps (*Palæmon* and *Mysis*), COUCH[b] *Turritella terebra* and Hermit-crabs (*Pagurus*), and GOTTSCHE *Ophiuræ*. The intestine, abdominal cavity, and liver of the Rough Dab are very often infested with entozoa; and parasitic crustaceans are often found on its branchiostegal membrane and branchial arches.

In Scandinavia the Rough Dab is taken only occasionally, together with other Flatfishes and with the same tackle. As an article of food it is the least esteemed of all the Flatfishes. (SUNDEVALL, SMITT.)

SUBFAMILY **BOTHINA.**

Snout not elongated, lower jaw most prominent. Mouth middle-sized or large, only slightly or almost imperceptibly unsymmetrical; jaw-teeth almost as well-developed on the eye side as on the blind side. Ventral fin of the eye side set more or less exactly at the ventral margin, often in a straight line with the base of the anal fin. Rays of the ventral fins more or less separated at the base and attached to a forward process of the pelvic bones, whose shaft is directed downwards. Eyes large or middle-sized. Pseudobranchiæ and gill-rakers well-developed.

Up to this point we have traced one of the courses of development of the family back from its culminating point, the most unsymmetrical forms, the Soles, to the Halibuts, which have adhered more closely to the symmetry shown by other fishes than the remaining members of the family. The present subfamily shows the least degree of asymmetry in the structure of the mouth, but, on the other hand, has advanced furthest in the asymmetry of the fins. The ventral fins, in the first place, are removed towards the blind side so far that the ventral fin of the eye side acquires the appearance of an anterior anal fin, a peculiarity which also occurs in some of the members of the subfamily of the Soles. But, in addition to this, the posterior parts of the dorsal and anal fins are generally drawn over towards the blind side so far that their terminations on this side are closely approximated to each other in front of the caudal fin. In the position of the eyes too, some of these forms (a part of the genus *Platophrys*) attain the highest degree of asymmetry, the wandering eye finally taking its place so far back and so high up that it seems externally to belong to the occipital region. The direction of the asymmetry in this subfamily may thus be said to be opposite to the direction of that which determines the structure of the Soles.

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[a] Isis, 1828, p. 880.

[b] See COUCH, *Fish. Brit. Isl.*, vol. III, p. 153.

Among the peculiarities of the skeleton the structure of the pelvic bones first calls for attention. These bones are partly — in *Bothus rhombus* for example — of the same shape and position as in the symmetrical fishes, with the exception of the circumstance that they hang downwards from their point of suspension from the clavicular bones. They are stiletto-like, of an oblong triangular shape, at the superior (originally the anterior) end curved and tubular, with the narrow side (the base) set transversely across the body; and in the species mentioned the outer exterior corner forms a spinous process. But each of these bones sends out, in a forward direction, from the lower part of the outer side, a thin, narrow, triangular, osseous disk (pointed in front), which is set vertically in the longitudinal direction of the body (horizontally when the body is in its usual position), and which follows the ventral margin, under the posterior (lower), forward prong of the urohyoid (basibranchiostegal) bone, but is united to this bone solely by ligaments. The outer surface of this osseous disk represents the upper (posterior or inner) surface, and its anterior point the hind (lower), exterior corner, of the pelvic bones of ordinary fishes. The six ventral rays, which are more or less apart from each other, articulate with the under surface of this disk, their outer side thus corresponding to the upper (inner) side of the rays of the ventral fins in ordinary fishes. Another peculiarity which distinguishes the skeleton of these fishes from that of the preceding subfamily, is that the caudal vertebræ are furnished with comparatively well-developed transverse processes.

A characteristic of most of these forms — though it also occurs in the preceding subfamily, in the genus *Pseudorhombus* for example — lies in the shape of the pupil. On its inner side (in the lower eye the upper side, in the upper eye the lower) the iris forms a semicircular or quadrangular process, which thus hides a part of the pupil.

Almost all these forms — the genera *Mancopsetta* (from the Indian Ocean off Prince Edward Island), *Citharus* (from the Mediterranean), *Citharichthys*[a] (from the tropical parts of the Atlantic, Australia, and the west coast of North America), *Platophrys*[b] (from the Temperate and Tropical seas all round the world). *Bothus*, *Lepidorhombus*, and *Scopthalmus* (from the Atlantic and the Mediterranean), as well as *Zeugopterus* (from the Atlantic coast of north-western Europe) — are sinistral. Only the Chinese genus *Samaris*, which is remarkable in many other respects, has the eyes on the right side of the body[c]. The vent usually lies on the blind side, but the anal papilla in most cases on the eye side, and often even above the ventral fin of this side. In all these forms the dorsal fin begins in front of the eyes, on the bridge of the snout or the blind side thereof.

The forms of this subfamily that belong to the Scandinavian fauna may be distinguished as follows:

A: Jaw-teeth set in a single or double row. Branchiostegal membranes united inferiorly in a straight line with each other.
  Genus *Platophrys:* Jaw-teeth of uniform size (no canines); vomer toothless.
    Subgenus *Arnoglossus:* Scales middle-sized and deciduous ... . *Platophrys (Arnoglossus) laterna.*
B: Jaw-teeth set in several rows, cardiform. Branchiostegal

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[a] + *Hemirhombus* + *Anticitharus*.

[b] + *Arnoglossus*.

[c] According to GÜNTHER's description the eyes are set on the left side of the body in *Lophonectes*, from Port Jackson; but according to his figure this genus is dextral.

membranes inferiorly independent or meeting each other in different planes, the one covering the other to a greater or less extent.

a: Ventral fins free from the anal fin.
  aa: Scales, when present, cycloid. Median wall of the branchial cavity unbroken under the lower pharyngeals.
  Genus *Bothus:*
    α: Rays in the anal fin at most 50 .... *Bothus maximus.*
    β: Rays in the anal fin more than 50 .... *Bothus rhombus.*
  bb: Scales, on the eye side at least, ciliated. Median wall of the branchial cavity broken between the lower pharyngeals and the urohyoid bone.
    α: Head of the vomer furnished with teeth. Scales of the blind side cycloid.
  Genus *Lepidorhombus* .... *Lepidorhombus whiff.*
    β: Vomer toothless or with indistinct teeth. Scales of the blind side also ciliated.
  Genus *Scophthalmus* .... *Scophthalmus norvegicus.*
b: Ventral fins united by the fin-membrane to the beginning of the anal fin. Median wall of the branchial cavity broken between the lower pharyngeals and the urohyoid bone. Head of the vomer furnished with teeth.
  Genus *Zeugopterus* .... *Zeugopterus punctatus.*

GENUS PLATOPHRYS.

Jaw-teeth of uniform size, small and pointed, set in a single or double row on the intermaxillary bones and in one or several rows in the lower jaw. Lower pharyngeal teeth set in a single row. All the fin-rays, except the caudal rays proper, simple. Branchiostegal membranes inferiorly united into a broad, free fold: branchiostegal rays 7. Median wall of the branchial cavity unbroken under the lower pharyngeals. No teeth on the vomer, palatine bones, or tongue. Ventral fins free from the anal fin.

This genus was established by SWAINSON[a] expressly to include the forms that are distinguished by the wide separation of the eyes, and belong chiefly to the tropical seas. BLEEKER[b] and subsequently GÜNTHER[c] called the same group *Rhomboidichthys;* but the former soon[d] restored SWAINSON's name, and in his great work on the fishes of the Dutch East Indies he combined with this genus, though with the rank of a subgenus, another, *Arnoglossus*, which he had formerly[e] believed to require an independent place in the system. This union had been previously foreshadowed, however, by GÜNTHER, who in his *Catalogue*, referred to the genus *Rhomboidichthys* a species (*Rh. mogki*) with fairly narrow, though concave, interorbital space. In this manner the genus *Platophrys* is made to embrace the Bothoid forms which are most widely separated by the different position of the eyes, but even in this respect connected by intermediate forms, and which fall under the characters given above. Most of these species, in which the eyes are more or less far apart, are further characterized by small and firmly attached scales — at least 80 in a row along the sides of the body — and, generally speaking, by the great depth of the body. These small-scaled species, which belong to the tropical seas all round the globe and also to the Mediterranean and the Sea of Japan, form the subgenus for which BLEEKER retained the name of *Platophrys*.

[a] *Nat. Hist. Fish., Amphib. and Rept.*, vol. II, pp. 187 and 302.

[b] Act. Soc. Scient. Indo-Neerl., I (1856), *Beschr. Vischs. v. Manado en Makassar*, p. 67

[c] *Cat. Brit. Mus., Fish.*, vol. IV, p. 431.

[d] Versl. en Meded. Akad. Wetensch. Amsterd., XIII (1862), p. 426.

[e] L. c., p. 427.

SUBGENUS **ARNOGLOSSUS**.

Scales deciduous, at most about 60 in the lateral line. Form of the body more or less closely resembling that of the Sole.

Arnoglossus[a], i. e. lamb's tongue[b], was the name applied by RONDELET to a well-known Mediterranean species, supposed by WILLUGHBY[c] and RAY[d] to be also known to the Cornish fishermen under the name of Lantern. The deciduousness of the scales and the thinness and transparency of the body were given as the main characters. As we now propose to show, it is as yet impossible to decide with entire certainty whether more than one species of this subgenus is known in Europe; and we find the same difficulty with regard to the non-European species. BLEEKER, however, has described 5 species from the East Indies, one of which, *Arnoglossus tapeinosoma*, was taken off Hong Kong by the Vega Expedition, on a clayey bottom in 22 fathoms of water[e].

THE MEGRIM OR SMOOTH SOLE (SW. RADFLÄCKIGA TUNGEHVARFVEN[f]).

PLATOPHRYS LATERNA.

Plate XIX, fig. 4.

Greatest depth of the body varying between 27 and 36 %, and the postorbital length of the head (from the back margin of the lower eye) between $10^1/_2$ and 14 %, of the length of the body. Lower posterior corner of the pelvic bones ending in preanal spines directed backwards. Body transparent, on the eye side grayish carnation or brownish gray, without spots or marked with brown spots along the lateral line and the bases of the dorsal and anal fins: eye side of the fins dotted with brown.

R. br. 7[g]; *D.* 83—93; *A.* 59—71; *P.* sin. 10 l. 11: dextr. 9 l. 8[h]: *V.* 6; *C.* $x+11+x$; *L. lat.* 52—55[i]; *L. tr.* ca 26.

Syn. *Arnoglossus lævis*, RONDEL., l. c.; *Arnoglossus* seu *Solea lævis*, WILL., RAY, ll. cc.; *Smooth Sole* et *Lantern Fish*, PENN., *Brit. Zool.* (1786), vol. III, p. 204.

Pleuronectes Laterna, WALB., *Ichth. Art.*, part. III, p. 121.

Pleuronectes diaphanus, SHAW., *Gen. Zool.*, vol. IV, p. 309.

Pleuronectes casurus, HANMER apud PENN., *Brit. Zool.* (1812), vol. III, p. 325, tab. LIII.

Pleuronectes leotardi, RISSO, *Ichth. Nice*, p. 318 = *Rhombus nudus.*, ID., *Eur. Mér.*, tom. III, p. 251.

Pleuronectes Arnoglossus, BL., *Syst. Ichth.*, ed. SCHN., p. 157; FLMNG, *Brit. Anim.*, p. 197.

A: Forma macrocephala, humilis: longitudine capitis circa $^{24}/_{100}$ longitudinis totius corporis, altitudine maxima corporis circa $^{28}/_{100}$ ejusdem longitudinis, cujus partem minimam $^{12}/_{100}$ longitudo mandibulæ superat. Color corporis translucidi in latere oculari cinereo-carneus, immaculatus.

Pleuronectes arnoglossus, BP., *Icon. Fn. Ital.*, tom. III (Pesci), tab. No. 97, fig. 3; CANESTR., Arch. Zool., Anat., Fisiol., vol. I, fasc. I, p. 14, tab. I, fig. 4; MOR. *Hist. Nat. Poiss. Fr.*, tom. III, p. 328.

Arnoglossus Laterna, GTHR, *Brit. Mus. Cat., Fish.*, vol. IV, p. 415; STEIND., Stzber. Akad. Wiss. Wien, Math. Naturw. Cl., LVII, I (1868), p. 716; GIGL. Espos. Intern. Pesc. Berl. 1880, Sez. Ital., Catal. p. 98.

B: Forma microcephala, altior: longitudine capitis circa $\frac{19-23}{100}$ longitudinis totius corporis, altitudine maxima corporis circa $\frac{33-35}{100}$ ejusdem longitudinis, cujus partem maximam $^{12}/_{100}$

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[a] ἀρνός and γλῶσσα.

[b] "Agninæ linguæ nomen", RONDELET, *De Pisc.*, lib. XI, cap. XIV, p. 324.

[c] *Hist. Pisc.*, p. 102.

[d] *Synops. Pisc.*, p. 34.

[e] The same species is probably described from Hong Kong by GÜNTHER (*Challenger Report*, *Shorefishes*, p. 58) under the name of *Arnoglossus tenuis*, though GÜNTHER's specimen is stated to have been without pelvic spines.

[f] MALM, l. c.

[g] According to COLLETT and LILLJEBORG only 6.

[h] Sometimes 10, according to LILLJEBORG.

[i] Sometimes 47, according to GÜNTHER. As a greater or less number of the scales have fallen off, however, in the great majority of cases, mistakes may easily be made in counting them.

longitudo mandibulæ æquat. Color corporis translucidi in latere oculari cinereus[a], maculis et punctis fuscis conspersus.

Rhombus arnoglossus, Yarr., *Hist. Brit. Fish.*, ed. 2, vol. II, p. 345.

Pleuronectes conspersus, Canestr., Arch. l. c., p. 10, tab. I, fig. 2; Gthr. l. c., p. 416; Steind., l. c.; Mor., l. c., p. 329; Gigl., l. c.

Megrim, Couch, *Fish. Brit. Isl.*, vol. III, p. 177, tab. CLVIII.

Rhombus soleaformis, Malm, Förh. Skand. Naturf. M. Stockh. 1863, p. 413; *Gbgs, Boh. Fn.* (*Arnoglossus*) p. 519; Gbgs, Naturh. Mus. Årsskr. III (1881), p. 24.

Arnoglossus laterna, Coll., Forh. Vid. Selsk. Christ. 1874, Tillægsh., p. 140; ibid. 1879, No. 1, p. 77; Day, *Fish. G:t Brit., Irel.*, vol. 2, p. 22, tab. XCIX, fig. 2; Coll., N. Mag. Naturv. Christ., Bd. 29, p. 101; Lillj., *Sv., Norg. Fisk.*, vol. II, p. 329.

Obs. Among the fishes of the Mediterranean Canestrini in 1861 distinguished between two species within the limits fixed by his predecessors for *Pleuronectes arnoglossus*. The first, which was adopted by Günther under the name of *Arnoglossus laterna*, without spots on the fins and with the length of the lower jaw at least $^1/_8$ of that of the body, was stated by Canestrini to be common in the Gulf of Genoa during winter, but rare during summer, from the month of April. The second, *Pleuronectes* (*Arnoglossus*) *conspersus*, with the vertical fins punctated with brown and with the length of the lower jaw less than $^1/_8$ (sometimes $^1/_{11}$) of that of the body, he stated to be a common summer-fish in the same vicinity, but rare in winter. The Royal Museum has acquired from the Mediterranean one specimen of the first form, 97 mm. in length, which was taken in March, 1874, off Salerno by Professor C. Lovén, and two specimens of the latter, respectively 97 and 111 mm. long, which were taken in October, 1856, off Venice by Professor O. Sandahl. On comparing these forms with each other and with two Scandinavian specimens — the first 114 mm. in length and taken off Torrboskär (the Skaw) in July, 1878, during the expedition of the gunboat *Gunhild*, the second 116 mm. long and taken during the summer of 1879 at the zoological station of Kristineberg in Bohuslän — we find the same question before us as that we have had to deal with in our treatment of the relation between *Pleuronectes glacialis* and *Pl. cicatricosus* or between *Drepanopsetta platessoides* and *Drep. limandoides*[b]. The one form has a deeper body and a shorter head, thus representing partly the female characters and partly a more advanced stage of development. That the two forms of the European Megrim are also geographically distinct, at least to a certain extent, appears not only from Canestrini's observation that they repair to the fishing-grounds at different seasons of the year — a fact which may indicate that they must be regarded, generally speaking, as inhabitants of distinct localities — but also from the circumstance that the one form, Bonaparte's and Canestrini's *Pl. arnoglossus*, has probably never been found in Scandinavia, perhaps not even in Great Britain — at least to judge by Yarrell, Couch, and Day — though Moreau states that he obtained it off Havre. As in the case of the Rough Dab, however, we here, too, allow the older specific name to do duty for both forms, especially as this name was adopted by Walbaum with references to the works of both Rondelet and Ray, and thus may be applied in all probability to both forms.

The European Megrim attains a length of from 17 to 19 cm., the depth of the body, which is greatest at about the end of its first third, being at most 36 % of the total length or 45 % of the length from the snout to the base of the caudal fin. In the Scandinavian form the greatest depth is, as a rule, more than 32 %[c] of the former length or 38 % of the latter. Thus, the form of the body, as well as the close proximity to each other of the vertical fins on the tail, most reminds us of the Soles, a circumstance which led Malm to call the species *soleæformis*. But the body is thinner than that of the Scandinavian *Solea*, the thickness of the head across the opercula, in spite of the fact that this is the thickest part of the body, measuring only about 5 % of the length of the body or between 14 and $15^1/_2$ % of its greatest depth. The chief singularity in the appearance of the fish is also its transparency. The body being so thin, we can easily understand one of the circumstances pointed out by Rondelet[d] as characteristic of the Megrim, namely that it requires no more boiling than *nonnat*[e]. Its transparency is further enhanced by the texture of the scaly covering. Most of the scales of the body, especially on the trunk and the hind part of the head, are comparatively large, thin, and deciduous. On the eye side they are ciliated at the hind margin, on the blind side smooth-margined. The lateral line is distinct only on the eye side, and forms a sharply marked arch above the abdominal region. More firmly attached, small scales, ciliated at the outer margin, cover the dorsal and anal fins, the ventral fin of the eye side and the eye side of the snout. The caudal fin, on the other hand, is covered with small scales, on the eye side ciliated, but on the blind side smooth-margined. On the first three fins the scales are set in a single row on each ray, while the branched rays of the caudal fin are furnished with a row for each branch. On the eye side the maxillary bone and the branch of the lower jaw are also covered with scales, but the intermaxillary bones, as well as the lips, are naked. These small scales on the head and fins are often the only ones that are left after the fish is caught; but the scales of the lateral line are at least more firmly attached than the scales of the rest of the body itself. As a rule, however, the dermal folds in which the scales have been set, are so distinct that the number of the scales may be ascertained. In the Scandinavian form we have found the number of scales in an oblique, transverse row at the beginning of the straight part of the lateral line, just behind the arch (where the body is deepest), to be 13 above and 13 below the lateral line.

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[a] Fusco-argillaceus, sec. Malm.

[b] Cf. also the relation between *Beryx decadactylus* and *B. splendens* (p. 68, above) or between *Brama longipinnis* and *Br. Raii* (p. 80, *Obs.*, above). In the present case too, strange to say, we find parallels between very closely related Atlantic and Pacific forms.

[c] In Collett's smallest specimen, 79 mm. long, the greatest depth of the body according to his measurements was 31·6 % of the length of the body.

[d] Statim atque ignem vidit coctus est, quemadmodum aphya.

[e] Cf. above, p. 264.

In the form known as *Platophrys conspersus* the length of the head measures 19—22$^1/_2$ %[a] of the total length of the body, 23—27 %[b] of the length from the snout to the base of the caudal fin, or 56—66 %[c] of the greatest depth of the body. The snout is comparatively blunt, its upper and lower profiles meeting almost at a right angle; and the mouth, with the lower margin of the under jaw straight, rises, when closed, at an angle of about 45 degrees. The length of the lower jaw, which is somewhat less on the eye side than on the blind side, and in most cases relatively less in old specimens than in young, measures 10—12 % of the length of the body[d]. The chin is furnished with a distinct, though small knob; and the anterior margin (symphysis) of the lower jaw is straight and together with the lower margin forms an obtuse angle. The dorsal contour of the snout seems somewhat tumid behind the intermaxillary bones, but farther back is depressed. This is due to the comparatively advanced development of the articular part of the maxillary bones, which in other species of the genus, e. g. in *Platophrys lunatus* from the tropical part of the Atlantic, sends out a robust, spinous, bony knob in a forward direction. In both forms of *Pl. laterna* we have found the length of the maxillary bones to be exactly the same on the eye side as on the blind side[e], and to measure, in the form known as *Pl. conspersus*, 7—9 % of the length of the body[f], being relatively greater in young specimens than in old. Behind (underneath) the maxillary bone is slightly extended in breadth, and at the posterior (lower) end obliquely truncate and slightly concave, more so on the eye side than on the blind side. The eyes are of moderate size, measuring 18 to 20 % of the length of the head, and are, as usual, relatively larger in young specimens than in old. Their position with regard to each other seems also to vary, the variation being to a certain extent individual, but chiefly according to age. In the young specimens before us they are set almost in a straight line with each other, while in the oldest specimen half the upper eye is behind the lower, the distance between the latter and the tip of the snout being somewhat more than its own length. The nasal cavity of the eye side is naked, but surrounded with small scales, and is situated in front of the eyes, almost exactly in a straight line with the narrow interorbital ridge. The position of the nasal cavity of the blind side is similar, but higher, its longitudinal diameter, when produced, passing through the middle of the upper eye, which is visible through the body on this side. The anterior nostril is raised on both sides of the body into an obliquely-truncate tube, or elongated at the hind margin in a lobate shape. The posterior nostril is smaller, and only slightly raised at the margin. The interorbital space, which in other species of the genus *Platophrys* is remarkable for its great width and distinct concavity, here consists of an extremely narrow ridge, the width of which is only about $^1/_3$ of the longitudinal diameter of the eye. In old specimens the preoperculum is nearly rectangular, but rounded at the corner, and with the upper, vertical branch $^1/_3$ or $^1/_4$ longer than the lower, horizontal branch: in young specimens it is more obtuse-angled, and the two branches are more equal in size. The operculum, suboperculum, and interoperculum, are thin and transparent, and together form an arch of almost uniform width, until the last of the three grows narrower in front, below the preoperculum. At the hind margin, however, at the division between the operculum and suboperculum, this arch is distinctly notched. The branchiostegal membranes are anteriorly (inferiorly) united into a broad, transverse fold, which fits into the bend of the urohyoid bone, and extends to the bottom of this bend. This transverse fold is marked off by a deep fold from the lateral parts of the branchiostegal membranes, and contains only the foremost (lowest) pair of rays, which, as in the preceding genus, are exteriorly (distally) coalescent. The other six rays on each side are fine, long, and sabre-shaped, the two anterior, as well as the three posterior, lying close to each other.

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[a] In Scandinavian specimens at most 21$^1/_2$ %, in one of our two Mediterranean specimens 22$^1/_2$ %. In our specimen of *Pl. arnoglossus* 24·7 %.

[b] In Scandinavian specimens at most 26 %; in one of our two Mediterranean specimens 27·5 %. In our specimen of *Pl. arnoglossus* 29·2 %.

[c] In the smallest of COLLETT's specimens, however, this proportion is 68 %. In the Royal Museum specimen of *Pl. arnoglossus* it is 88·9 %.

[d] In the Royal Museum specimen of *Pl. arnoglossus* the length of the branch of the lower jaw on the blind side is 14·1 % of the length of the body.

[e] The asymmetry of the mouth and the greater shortness of the head, especially of the postorbital part, and of the pectoral fins are the only perceptible differences we have succeeded in discovering between the Chinese *Platophrys tapeinosoma* and *Platophrys conspersus.*

[f] In our specimen of *Platophrys arnoglossus* the length of the maxillary bones is 10$^1/_2$ % of that of the body.

The dorsal fin begins on the blind side of the head, close to and just above the anterior nostril, the first interspinal bone being situated at the upper margin of the nasal cavity. The length of the fin measures 77 or 78 %, and its height (the longest ray) 9 or 10 %, of the length of the body. It terminates exactly at the dorsal edge, and sometimes almost touches the uppermost supporting ray of the caudal fin, though it is sometimes separated from the latter by two or three scales' breadth. It is of fairly uniform height, the anterior rays growing uniformly and gradually longer, and the posterior shorter. The anal fin resembles the dorsal in shape, is of almost the same height, and its length is about 59—63 % of that of the body. The distance between it and the tip of the snout is 24 or 25 % of the length of the body, and it terminates posteriorly in the same manner as the dorsal fin. The caudal fin, the length of which is about 16—18 %[a] of that of the body, is evenly rounded at the hind margin or somewhat pointed in the middle, and is made up of 11 branched rays, and 3 supporting rays above and below[b]. The pectoral fins are narrow and pointed. In the pectoral fin of the eye side, the length of which is about 13—16 % of that of the body, the third ray is the longest. The length of the pectoral fin of the blind side is only 8 or 9 % of that of the body. The ventral fins are especially remarkable for their great difference from each other, the base of the one (on the eye side) being more than twice as long as that of the other[c], and extending from the anterior end of the lower extremity of the urohyoid bone to the beginning of the anal fin. In height, however (the length of the longest — the 4th or 5th — ray[d]) they are more alike. Between their posterior rays and the membranes that unite these rays to the belly, the preanal spines of the pelvic bones appear, the one (that of the eye side) just in front of and close to the other. The vent lies on the blind side, either just at the end of the ventral fin of this side, where the posterior fin-membrane terminates, or within (below) the end of this membrane, and in a line with the first ray of the anal fin. Exactly opposite, on the eye side, lies the small, but distinct urethral papilla.

The coloured side of the body is described by Malm as "brownish clay-gray, with a row of punctiform, blackish brown spots along the lateral line, and a row of similar, smaller spots a little distance from the bases of the dorsal and anal fins. These fins, as well as the others, have blackish dots and streaks on the rays, the markings being most distinct in a line with the dark spots on the body, and thus suggesting that they may perhaps be regarded as traces of evanescent transverse bands on the whole body. The membranes of the left pectoral fin are black between the last three rays for $^2/_5$ of their length, at the tips of the rays. Iris yellowish green and, with the exception of the part bordering on the pupil, spotted with grayish brown." In the specimens preserved in spirits in the Royal Museum the whole body is orange, with almost invisible traces of the markings described by Malm, excepting the spots on the dorsal and anal fins, but a dark brown colour has left very distinct traces on the tips of the ventral fins. As we have failed to procure any fresh specimen, we have taken advantage of Dr. A. H. Malm's kind permission, and borrowed for this work the figure coloured by Mr. Thornam for Dr. Malm's father.

The Megrim can scarcely be considered rare on the west coast of Scandinavia, as it has often been met with in Christiania Fjord, Gullmar Fjord and the island-belt of Gothenburg. Collett mentions 17 specimens from the first locality, and MALM 14 from Gullmar and the neighbouring waters and 2 from the island-belt of Gothenburg. The Royal Museum possesses two Scandinavian specimens, one, as we have mentioned, from Gullmar, and the other from the Skaw, where it was taken in 22 fathoms of water, on a clayey bottom. On other occasions the species has been found in shallower water, sometimes no more than 5 fathoms deep, and on a bottom of pure sand or sand mixed with clay. In Scandinavia the Megrim is usually taken in the seine, while fishing for Herrings and Sprats. A specimen was once received by MALM that "had been taken in a Flounder-net at a depth of 17 fathoms."

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[a] 15·5—18·5, according to our measurements; 16·4—20·2, according to Collett's.

[b] In the Royal Museum specimen, which is 98 mm. long, of the very nearly related species, *Platophrys tapeinosoma* from Hong Kong, there are only 9 branched rays in the caudal fin, but 4 supporting rays on each side. However, it is very common among the Teleosts that young specimens differ in this respect from older ones.

[c] The length of the base of the former is about 7 or 8 %, of the latter about $3^1/_2$ %, of the length of the body.

[d] About 6 or 7 % of the length of the body.

The food of the Megrim is probably of the same nature as that of the other small Flatfishes: crustaceans, mollusks, and fish. In the stomach of a Megrim 165 mm. in length COLLETT found a *Gobius minutus* about 63 mm. long. In the stomach of a female 138 mm. long MALM found two specimens of *Aphya minuta*, the larger 44 mm. in length. These circumstances indicate no little voracity. Again, the Megrim itself constantly falls a prey to all kinds of deep-sea fishes, and has been found in the stomach of the Cod and the Conger.

The spawning-season of the Megrim occurs apparently in the summer-months, between May and August. At the end of June COLLETT took a female 162 mm. long that seemed to have already deposited its spawn. The two specimens that ESMARK took in Christiania Fjord in May and at the beginning of June, 1863, were both gravid females. In one of these two specimens, according to COLLETT, the ovaries extended back to a point, the distance between which and the base of the caudal fin was only slightly more than the length of the head; and the number of the eggs was about 50,000. MALM found specimens ready to spawn between the 9th and 21st of August, 1861, off Kristineberg; but he remarked that it was only towards the end of this period that the roe began to ripen and "run."

As the Megrim is so small and thin, it can scarcely be employed as human food in any other form than *nonnat*. In Venice, according to NINNI[a], it is sold among other fish under the name of *menuaggia*. It might certainly be of some importance as bait; but in Scandinavia it is found far too seldom to be of any economical importance even in this respect.

GENUS **BOTHUS**.

Jaw-teeth of uniform size (without canines), pointed, recurred, small, and set in a card on the intermaxillary bones as well as in the lower jaw. Head of the vomer also furnished with small teeth: but the palatine bones and tongue smooth. Lower pharyngeal teeth set in several rows. Most of the fin-rays usually branched. Branchiostegal membranes inferiorly free, at least in part, from each other, but meeting in different planes and crossing each other. Branchiostegal rays 7. Median wall of the branchial cavity unbroken below the lower pharyngeals. Ventral fins free from the anal fin. Scales, when present, cycloid. Anal and preanal spines wanting.

The name of *Bothus* — which, according to RAFINESQUE, occurs even in ARISTOTLE, but also reminds us of the French *turbot*, the German *Butte* and the Swedish *Butta*[b] — was applied by RAFINESQUE[c] to a genus meant to represent KLEIN'S *Rhombus* and to be typified by LINNÆUS'S *Pleuronectes rhombus*. As KLEIN'S *Rhombus*, however, is an ante-Linnæan name which LACEPÈDE has transferred to another genus[d], the name given the genus by RAFINESQUE claims precedence, though it must be regarded as partly synonymous with the preceding genus, for which it was employed by BONAPARTE.

Only three species of *Bothus* are known, which belong to the north of the Atlantic, the Mediterranean, and the Black Sea. One of these species, the North American *Bothus maculatus*, is so thin and transparent

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[a] Espos. Int. di Pesca in Berlino 1880, Sez. Ital., Cat., p. 180.

[b] AGASSIZ (*Nomenclator*) endeavoured to explain this name by the Greek *βάϑος*, *depth*.

[c] *Caratteri di alcuni nuovi generi* etc. (1810), p. 23.

[d] ARTEDI'S *Stromateus*.

— though, according to STORER, it attains a length of from 12 to 18 dm. — as to remind us very strongly of the Megrim. The two others, however, are among our better Flatfishes — one of them among the best and fattest. They are also characterized by the exceptionally deep (short) form of the body, which is relatively shorter than in any of the other Flatfishes. The mouth is turned up sharply. The eyes are well separated, most so among the Scandinavian forms of the subfamily, though not nearly so far apart as in some members of the preceding genus.

Few as are the species of this genus, their relations to each other, especially in the case of the two that belong to the European fauna, are in the highest degree interesting. Not only is their geographical range so extensive as to admit of the form's being influenced by very dissimilar environments[a]; but in addition to this a large number of intermediate forms are known, which can obviously be explained only on the assumption that they are hybrids[b]. MALM has described one of these forms under the name of *Rhombus hybridus.* Both his specimens were females, and most closely resembled *Bothus maximus.* The Royal Museum has received from Strömstad, through Mr. C. A. HANSSON, two males, one of which is more like *Bothus rhombus.* Thus it is very difficult to find fixed, constant characters for the two species — for many different combinations may probably be found. However, the forms known in Scandinavia may be distinguished as follows:

- I: Number of rays in the anal fin at most 50. Least depth of the tail less than 20 % of the greatest depth of the body. Abdominal curve of the lateral line high and short, its height being about half its length, which is about $^3/_4$ of the length of the middle caudal rays.
  - *A:* Length of the head behind the lower eye more than 17 %, and of the left maxillary bone more than 12 % of the length of the body .... *Bothus maximus.*
  - *B:* Postorbital length of the head less than 17 %, and of the left maxillary bone less than 12 % of the length of the body .... *Bothus maximus hybridus.*
- II: Number of rays in the anal fin more than 50. Least depth of the tail more than 20 % of the greatest depth of the body. Abdominal curve of the lateral line low and long, its height being about $^1/_3$ of its length, which is about equal to that of the middle caudal rays.
  - *A:* Postorbital length of the head more than 16 %, and the greatest depth of the body more than 50 %, of the length of the body .... *Bothus rhombus hybridus.*
  - *B:* Postorbital length of the head less than 16 %, and the greatest depth of the body less than 50 %, of the length of the body .... *Bothus rhombus.*

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[a] If we compare, for example, CANESTRINI's descriptions of *Bothus maximus* and *Bothus rhombus* from the Mediterranean with specimens of these species from Scandinavian waters, we find that, though the differences are parallel — the former having a larger head, fewer rays in the dorsal and anal fins etc. — still the boundaries between the species are entirely different in the Mediterranean and in our fauna.

[b] We are still without the necessary experimental evidence to show that this is the case; and that this is the only operating influence is scarcely probable, for these intermediate forms occur in localities, in the Baltic for example, where only one of these species is found in its typical form.

THE TURBOT (SW. PIGGHVARFVEN).

BOTHUS MAXIMUS.

Plate XVIII, fig. 1.

Greatest depth of the body more than 50 %, length of the head more than 28 %, postorbital length of the head more than 17 %, length of the maxillary bones more than 12 %, length of the right branch of the lower jaw more than 15 %, distance between the anal fin and the tip of the snout more than 30 %, length of the base of the left ventral fin more than 10 %, of the right ventral fin more than 8 %, and greatest thickness of the body more than 8 %, of the length of the body. First rays of the dorsal fin simple or only indistinctly branched. Number of rays in the dorsal fin less than 70, in the anal fin less than 50. Least depth of the tail less than 20 %, and the length of the caudal fin at the middle less than 36 %, of the greatest depth of the body. Body furnished on both sides or at least on the eye side with scattered, pointed, spinous tubercles, but otherwise naked, though furnished with soft, verrucose, closed scale-sacs mosaically arranged in the skin.

R. br. 7; *D.* 57—64[a]; *A.* 42—47[b]; *P.* 12[c]; *V.* 6; *C.* 2 + 13 + 2; *Lin. lat.* por. ca 76—80 ad. pinn. caud; *Vert.* 30—31.

Syn. *Rhombus aculeatus*, RONDEL., *De Pisc.*, lib. XI, cap. II, p. 310 (ψῆτταν Aristotelis credit: haud tamen liquet, quam familiæ speciem sub hoc nomine memoraverit Aristoteles); SCHONEV., *Ichth., Nomencl., Slesv. Holst.*, p. 60; GOTTSCHE, Wiegm. Arch. Naturg., I, 2 (1835), p. 172.

Rhombus maximus, WILL., *Hist. Pisc.*, lib. 4, cap. II, p. 94, tab. F, 2; LIN. (*Pleuronectes*), *Fn. Suec.*, ed. I, p. 112 (ex *Itin. gotl.*), No. 298; *Syst. Nat.*, ed. X, tom. I, p. 271; QVENS., Vet.-Akad. Handl. 1806, pp. 54 et 203; NILSS. *Prodr. Ichth. Scand.*, p. 58; EKSTR., Vet.-Akad. Handl. 1834, p. 56 (var.): SCHAGERSTR., Physiogr. Sällsk. Tidskr., p. 312; KR. (*Rhombus*), *Danm. Fiske*, vol. 2. p. 424; SUNDEV. (*Pleuronectes*), Stockh. L. Hush. Sällsk. Handl., H. 6 (1855), pp. 82 et 165; NILSS. (*Rhombus*), *Skand. Fn., Fisk.*, p. 636; CANESTR., Arch. Zool., Anat., Fisiol., vol. I, fasc. I (Genua 1861), p. 25, tav. III, fig. 1; GTHR, *Cat. Brit. Mus., Fish.*, vol. IV, p. 407; MGRN, *Finl. Fiskar* (disp.), p. 24; LINDSTR., Gotl. L. Hush. Sällsk. Årsber. 1866, p. 24 (sep.); STEIND., Stzber. Akad. Wiss. Wien, Math. Naturw. Cl. LVII, I, (1868), p. 714; COLL., Forh. Vid. Selsk. Christ. 1874, Tillægsh., p. 137; ibid. 1879, No. 1, p. 76; MALM, *Gbgs, Boh. Fn.*, p. 510; WINTH., Naturh. Tidsk. Kbhvn, ser. III, vol. XII, p. 37; BEN., *Fisch., Fischer., Fischz. O. u. W. Preuss.*, p. 93; MOR., *Hist. Nat. Poiss. Fr.*, tom. III, p. 338; MELA, *Vert. Fenn.*, p. 305, tab. IX; MÖB., HCKE, *Fisch., Osts.*, p. 89; DAY, *Fish. Gt. Brit., Irel.*, vol. II, p. 11, tab. XCVI; COLL. (*Bothus*), N. Mag. Naturv. Christ., Bd. 29 (1884), p. 100; LILLJ., *Sv., Norg. Fisk.*, vol. II, p. 305; SUNDM., MELA, *Finl. Fisk.*, tab. XXII.

In size the Turbot comes second among the Scandinavian Flatfishes. Specimens 5 or 6 dm. long are not rare on the west coast. NILSSON states that a Turbot was once brought by the fishermen of Råå to the market of Lund, which was 68 cm. long and weighed 7 kgm., and that off Kullen Turbots weighing 16 kgm. are sometimes taken. In the North Sea and the Irish Sea still larger specimens occur: THOMPSON[d] mentions one that weighed 20 kgm. According to DAY's observations the Turbot when $2^1/_2$ years old may have attained a weight of 10 lbs., and in 2 years more 20 lbs. About three feet or perhaps one metre is the maximum length that may with certainty be assigned to the Turbot; but RONDELET states that he saw a Turbot from the Atlantic 5 ells long, 4 ells broad and 1 foot thick, according to the measures then in use. To this statement we may trace the origin of the assertion which occurs in later writers, that the Turbot may attain a length of $7^1/_2$ ft.[e] These statements, it is true, are apparently borne out by others[f]; but they are based merely on hearsay.

The body is of a rounded rhomboid form. In typical females the greatest depth of the body is about 60 %, and in males about 56 %, of the length of the body. To this we may add the greatest height of the dorsal and anal fins, which is comparatively less in old specimens than in young, but fairly alike in the case of both fins, varying in the former specimens between about $13^{1}/_{2}$ and $11^{1}/_{2}$ %, and in the latter between about 14 and $11^{1}/_{2}$ %, of the length of the body. The total depth of the body with the fins at its deepest part is then about equal to the length of the body *minus* the caudal fin. The least depth of the body, which is less in the males, varies between about 10 and $11^{1}/_{2}$ % of the length of the body. The body is thickest in the anterior part of the abdominal region, the greatest thickness being even relatively greater in old specimens than in young, and measuring from 8 to 11 % of the length of the body.

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[a] Here, as in the case of the following fins, we confine ourselves to the numbers we have found in typical Turbots. In the intermediate forms the rays of the dorsal fin may be as many as 70 or, according to MOREAU, 72.

[b] According to MOREAU sometimes 56.

[c] Sometimes 11.

[d] *Nat. Hist. Irel.*, vol. IV, p. 200.

[e] OLSEN, *Piscatorial Atlas*, pl. 41.

[f] COUCH (*Fish. Brit. Isl.*, vol. III, p. 157) says that he "possessed a note of an example of which the weight was seventy pounds;" and PARNELL (Mem. Wern. Nat. Hist. Soc., vol. VII, p. 375) quotes an account of a specimen "that weighed one hundred and ninety pounds measuring 6 feet across."

The length of the head is about $28^{1}/_{2}$—$29^{1}/_{2}$ % of the total length of the body, 35—$36^{1}/_{2}$ % of the length of the body *minus* the caudal fin, or 48—$51^{1}/_{2}$ % of the greatest depth. Its shape, apart from the dorsal fin, fairly closely resembles that of the body, exclusive of the caudal fin, but inclusive of the dorsal and anal fins, the greatest depth of the head, *minus* the dorsal fin, being almost equal to its length. The straight profiles of the snout form a somewhat obtuse angle, and are continued by the anterior parts of the dorsal and ventral margins, which are only slightly curved, so evenly that the front half of the body is of a broad, cuneiform shape, while the posterior half, *minus* the caudal fin, is more like a semicircle. The mouth rises at an angle of about 45 degrees from the longitudinal transverse section of the body. In young specimens the tip of the snout is on a level with the lower margin of the upper eye and almost half-way up the body; but in older ones[a] it is on a level with the middle of the interorbital space and distinctly above the middle of the body, being set about $^{5}/_{9}$ of the way up the body. The maxillary bones grow broader behind (downwards). Their breadth at the hind (lower) extremity is about $^{1}/_{4}$ of their length, and in young specimens about $^{2}/_{3}$ of the diameter of the eye, in older ones equal to the latter. On the eye side this extremity is somewhat oblique, on the blind side almost straight and truncate. The intermaxillary bones taper to a point behind (downwards), extending about $^{2}/_{3}$ of the way along the upper jaw, and their curve, which fits into the curved anterior margin of the maxillary bones, gives a similar curve to the mouth. The nasal processes of the intermaxillary bones are well-developed, the distance from their top to the margin of the jaw being about half the length of the bones themselves, and the mouth is thus capable of some protrusion. Both the intermaxillary and the maxillary bones — the former at about the middle, the latter considerably nearer their articulation — are furnished at the upper margin with an erect, lobate process (see above, on these bones in the Halibut). The lower margin of the under jaw is slightly concave, and the chin-knob not very distinct, the symphyseal margin rising at an angle of about 135° and being of a height that in old specimens is only slightly less than the diameter of the eye. All these bones are almost symmetrical, with the single exception that in old specimens the length of the lower jaw is perceptibly greater on the blind side than on the eye side, or that we may even find the maxillary bone of the eye side a little longer than that of the blind side. We have found the length of the lower jaw to vary on the left side between about $14^{1}/_{2}$ and 16 % of the length of the body, and on the right side, where it is usually a little longer than on the left, between a little more than 15 and 16 % of the length of the body. The length of the maxillary bones varies on the left side between somewhat over 12 and $13^{1}/_{3}$ % of the length of the body, on the right side between $11^{1}/_{2}$ and $13^{1}/_{3}$ % thereof. The teeth are of uniform size, set as usual in cards and turned obliquely inward, with the cards on the branches of the lower jaw and on the intermaxillary bones broadest in front and growing narrower at the sides and behind. The lips are fleshy and on the inside thickly set with papillæ. Of the transverse palatal folds within the jaws the upper is especially well-developed. On the head of the vomer we find a little, transverse card of small teeth. The rest of the palate is smooth. The tongue is smooth and fleshy, but flat, with the tip free and rounded. The gill-rakers are denticulated, and as in most of the Flatfishes, set in a single row on the first branchial arch, though one or two of the rakers which belong to the inner row are developed, while on the three posterior branchial arches they are set in two rows, but in the rows are coalescent by pairs. The largest rakers among the 15 or 16 which we find on the first branchial arch, are about equal in length, in adult specimens, to the diameter of the eye. The upper pharyngeal teeth are set, as usual, in three, obliquely transverse cards. The lower pharyngeal teeth form two oblong cards, pointed at each end and with the teeth in the innermost row slightly larger than in the other rows.

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[a] We have not examined any old males.

The nostrils are set on the eye side in the mesial line of the nasal region in front of the eyes, the posterior nostril in a line with the anterior margin of the eyes, the anterior about the diameter of the pupil further forward. On the blind side they are set somewhat higher, but otherwise opposite to those of the eye side. The margin of all four is sometimes membranous and prolonged, in the case of the two posterior nostrils, however, only slightly and sometimes almost imperceptibly. In the two anterior nostrils this membranous prolongation of the margin is so marked behind that it may fall forward like a lid and cover the whole nostril. At the anterior margin a small, narrow flap may be found. In young specimens, even at a length of 50 mm., the eyes are still in a line with each other, or the upper eye may even lie somewhat further forward than the lower. This is a trace of the earlier stages of development, when the wandering eye first passed some way forward and then, when it had crossed the bridge of the snout, retired backwards on the eye side. In older specimens, on the other hand, at a length of 53 cm. for example, the upper eye has sometimes moved so far back that its anterior margin is in a line with the middle of the lower eye. The eyes are fairly equal in size, their relative size decreasing as usual with age. In Turbots 50 mm. long the longitudinal diameter of the lower eye is 37 or 38 % of the length of the head behind it, while in Turbots 53 cm. long this proportion has sunk to about 14 %. The breadth of the interorbital space on the whole also undergoes relative decrease, but to a much slighter extent; while until the fish has attained a length of 20 or 25 cm., this breadth increases not only absolutely, by growth, but in the above relation as well. In specimens 20 cm. long it measures about 19 or 20 % of the postorbital part of the head, but in specimens 53 cm. in length only about 16 % thereof. In specimens 50 mm. long the breadth of the interorbital space is only about $^1/_2$ the longitudinal diameter of the lower eye, while in specimens 53 cm. long it is $^6/_5$ of this diameter. The length of the snout, measured from the anterior margin of the lower eye, is about $^1/_4$ of that of the head. The preoperculum is rectangular, rounded at the angle, and with the vertical prong about $^1/_3$ longer than the horizontal. The operculum is triangular, like that of the Codfishes, with the hind lower side concave. Into this concavity the upper, narrower part of the suboperculum, the rest of which is of uniform breadth, is fitted, extending so far that it penetrates the posterior dermal flap which forms the end of the gill-cover, just above the axil of the pectoral fin. The interoperculum is of fairly uniform breadth, but as usual grows narrower in front, its breadth behind being about $^1/_3$ of the length of the upper jaw-bone. The branchiostegal membranes lie, as in most of the Flatfishes, in a deep fold below, where they meet and cross each other, most distinctly in old specimens. The innermost (foremost) of the seven branchiostegal rays in each membrane is not united at all to the corresponding ray on the other side, as we have found it in the preceding Flatfishes, but lies parallel to the other rays.

The dorsal fin is furnished with a thick skin, and begins on the blind side, just above and in front of the anterior margin of the anterior nostril, exactly following the dorsal edge throughout its length, without bending at all towards the blind side at its termination. As a rule the 30th—35th ray from the beginning is the longest, its length being about $12^1/_2$ or $11^1/_2$ of that of the body. Measured in a straight line, the base of the dorsal fin occupies from about $71^1/_2$ to $74^1/_2$ % of the length of the body. The fin contains 57—64 rays, those in the anterior half of the fin being generally simple or only indistinctly branched, while those in the posterior half are branched, sometimes with a simple ray inserted here and there. In young specimens the posterior rays are also simple or indistinctly branched. The distance between the anal fin and the tip of the snout is at least (in the males) 30 % and at most (in the females) 35 or 36 % of the length of the body. The 17th or 18th (sometimes even the 21st) ray from the beginning of the fin is the longest, being generally equal in length to the longest ray of the dorsal fin; and to the structure of the rays the same remark applies as in the case of the dorsal fin, with the addition that in this fin all the rays are still more frequently simple. Measured in a straight line, the base of the anal fin occupies about 58—$59^1/_2$ % of the length of the body. There is no projecting spine at the beginning of the anal fin, which in young specimens and the males is included between the posterior parts of the insertions of the ventral fins, and has the vent close beside it on the blind side, just behind the end of the ventral fin. The genital opening lies just behind or on the outer side of the vent, and in the males is furnished with a small, pointed papilla at the anterior margin. The urethral opening, with its more or less distinct papilla, lies on the eye side, just opposite the vent. The ventral fins are especially remarkable for the length of their base, in which respect the ventral fin of the eye side far surpasses that of the blind side. The length of the base of the former, which as a rule increases even relatively with age, varies between about $10^{1}/_{2}$ and 12 % of the length of the body, while in the case of the latter fin, in the specimens we have examined, this proportion is only 8—10 %. The height (longest ray) of these fins (the 4th or 5th) is almost the same in each case, relatively diminishing during the growth of the fish from about 8 % to about $6^{1}/_{2}$ % of the length of the body. The first ray, which is the shortest, is simple, the others, up to the 4th or 5th inclusive, gradually increase in length, as well as in the distinctness of the ramification, and the hindmost ray, which is somewhat shorter than the 5th, is also branched to about half its length[a]. In young specimens and in the males we have examined, the ventral fin of the eye side thus occupies the whole space at the ventral margin between the beginning of the anal fin and the lower anterior end of the urohyoid bone — which in its natural position lies just behind the articulations of the lower jaw. In the older females we have examined, on the other hand, the beginning of the anal fin has retired somewhat further back, simultaneously with the increase in the depth of the body. The pectoral fins are inserted in an obliquely vertical position, just below the middle of the depth of the body. The pectoral fin of the eye side is obliquely rounded, the 4th ray being the longest; while that of the blind side is more evenly brought to a blunt point, the 5th and 6th rays being the longest. The first ray is simple, the other 11 (or sometimes 10) are more or less distinctly and deeply branched. The length of the pectoral fin of the eye side varies between about $12^{1}/_{2}$ or (in the males) 13 % and 11 % of the length of the body; while the pectoral fin of the blind side is somewhat shorter, its length varying between 11 or 12 % and 9 % of the length of the body. The caudal fin is of a rounded, truncate shape. Its length at the middle is about 20—17 % of that of the body. In all the specimens we have examined the number of rays in this fin has been 2 + 13 + 2.

In this species the scales are in great part transformed into spinous tubercles scattered over the surface of the body or arranged in irregular, longitudinal rows. The tubercles of the eye side seem generally to be stronger and denser than those of the blind side, which is sometimes entirely without them. They are most closely set but smallest on the head, especially round the eyes, on the interorbital space, in a band-shaped patch from this point to the upper corner of the gill-openings, on the margin of the preoperculum — sometimes on the operculum, suboperculum and interoperculum also — and on the broad part of the maxillary bones. The spines on the branches of the lower jaw are also small but rather more scattered. Even on the lower (proximal) parts of the rays of the dorsal fin and the upper (proximal) parts of those of the anal fin similar spinous tubercles may be found; and on the rays of the caudal fin they often extend out beyond the middle. The variability in their occurrence is, however, considerable. We have found them largest and densest in a female 32 cm. long from the island-belt of Stockholm, most scattered in a female 53 cm. long from Bohuslän, though from this no rule can be deduced. In typical Turbots they are never so large as the eyes, but PALLAS[b] and NORDMANN[c] describe a Black Sea variety of this species, *Bothus mæoticus*, with spinous tubercles as broad at the base as the eyes or even broader. In form the spinous tubercles are more or less angular or round disks, with the spine at their middle. On the disk we find partly radiating grooves and fissures and partly concentric striæ, just as on ordinary scales. In the skin between these spinous tubercles we find shallow and, in most cases, distinctly bounded scale-sacs (follicles); but these sacs never contain any distinct scaly formation in typical Turbots.

The system of the lateral line generally resembles that of the rest of the Flatfishes in its extension over the head and body. The lateral line proper forms a sharp curve above the pectoral fin, but from this point runs straight back at the middle of the sides. In the curved part we have found from 28 to 33 opening-ducts, in the straight part from 48—52. Sometimes, however, on the blind side, we meet with a singular duplication of the lateral line. On this side, at the division between the curved and straight parts, it may either run upwards in an acute angle towards the back, and be continued from the apex of the angle by a small, ascending, dorsal branch, or the curved part, in addition to its straight continuation, may send out a ventral branch which descends behind and below the pectoral fin, but at once bends up again in a curve towards the hind (lower) angle of the pectoral fin. In the latter case three distinct ventral branches of the lateral line may descend from the bottom of this curve, but they bend so sharply forward that when they unite below, this takes place close to the vent[a].

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[a] According to KROYER down to the very base.

[b] *Zoographia Rosso-Asiatica*, part. III, p. 419.

[c] *Voy. Russ. Mér.*, DEMIDOFF, *Poiss.*, p. 534, tab. 28, fig. 2, tab. 29 et 30.

The internal organs in essential respects are the same as in most of the Flatfishes, but the intestinal canal is comparatively short. In accordance with the form of the body the abdominal cavity is also deep and short, its length being about $^{1}/_{6}$, but its depth about $^{1}/_{4}$, of the length of the body. The liver is comparatively small and scarcely fills the upper half of the left side of the abdominal cavity. Neither externally nor internally is there any marked division between the œsophagus and the stomach. The former runs straight back along the dorsal margin of the abdominal cavity to the point where the stomach bends straight down, almost at right angles to it. In this angle, however, the large longitudinal folds of the mucous membrane on the inner wall of the stomach reach their highest point of development, being even longitudinally divided in two, and thus giving us reason to assume the presence of a kind of cardia. At its lower end the stomach resembles a blind sac and is somewhat enlarged, but from this wider part it sends out in front, straight upwards, a narrower pyloric part which is sharply divided from the intestine, to which are attached two short but thick appendages, which fall back in a more or less sharp curve over the pylorus. A double coil of the intestine lies in front of the stomach, and the thick rectum coasts the front side of the pyloric part and the bottom of the stomach. Secondary abdominal cavities occur only in the females; but they extend far back, along the interhæmal spines of the anal fin. In a female 53 cm. long the two ovaries are almost equally long, their length from the genital opening being about 24 cm., and 14 cm. of this length lying behind the extreme end of the abdominal cavity. At the bottom of the abdominal cavity the ovaries are united to each other; and the urinary bladder lies between and behind their upper parts in the abdominal cavity.

The coloration of the eye side is extremely variable. Not only are the fry known for their great power of adapting their colour with comparative rapidity to the general colour and light of their environments; but even older specimens occur of lighter or darker shades, spotted or of uniform colour. The ground-colour is gray; but in the darker specimens this shades into brown or blackish brown, in the lighter ones to yellow or olive-green. Thus, we now find grayish brown Turbots with darker markings on the body, or specimens of a more unvaried, blackish brown colour, and with spots on the fins, as shown in v. Wright's figure, now grayish, greenish yellow ones, as we see them in the figures of Couch[b] and Sundman[c]. The blind side is, as usual, white or sometimes marked with irregular spots except in the *double* specimens, which also occur in this species, and in the fry, where the blind side is more or less nearly of the same colour as the eye side.

The Turbot in all probability occurs in fairly high northern latitudes. It is taken even among the Lofoden Islands, though only seldom. Its true habitat, where it is of more frequent occurrence, extends from the vicinity of Bergen to the Mediterranean; and as we have mentioned, it also enters the Black Sea, as well as the Baltic, where it is met with up to the district of Björneborg, though only seldom north of Ålands Haf. It is not common off Stockholm, but fairly large specimens are taken now and then in the island-belt, where Baron Cederström saw a specimen $2^{1}/_{2}$ kgm. in weight off Hölö outside Vermdö, in August, 1852[d]. In the island-belt of Mörkö, according to Ekström, the Turbot sometimes attains a weight of $2^{1}/_{2}$ or 3 kgm., though it is not common there either. According to Seidlitz[e] it occurs along the whole coast of the Baltic Provinces of Russia. According to Benecke[f] the Turbot is apparently not rare on the Prussian coast, where it is said to prefer spots near the mouths of rivers, and sometimes to enter the rivers as well as the lagoons or *Haffs*. On the east coast of Scania it is fairly rare[a], as well as in Kiel Bay, where according to Möbius and Heincke, however, Turbots weighing 10 kgm. are sometimes found. Off Bornholm according to Kroyer, it is quite common. From the Cattegat it sometimes penetrates into Liim Fjord, and like most of the Flatfishes, finds more congenial haunts on the Danish coast than on the Swedish, though it occurs all the way from the Sound along the coasts of Halland and Bohuslän. According to v. Yhlen[b] 3,966 Turbot were brought to Gothenburg market during the year 1879; but a large portion of them probably came from the Skaw. In the North Sea the Turbot-fishery is still more important. "Turbot are found," says Holdsworth[c], "more or less on all parts of the coast; the North Sea has long been famous for these fish, especially along the Dutch shore, where, during warm weather, they are caught in very shallow water. Large supplies of Turbot were formerly sent by the Dutch fishermen to the London market long before our own trawlers had established themselves on our eastern coast, or had found out how much was to be done in the North Sea. There are many of these fish also caught in the Channel, wherever there is trawling ground, and no doubt they are numerous in many places where, on account either of the depth of water or the nature of the bottom, no trawl has ever been worked. We have heard of extraordinary catches of turbot having been made in the neighbourhood of Wolf Rock, near the Land's End; but the depth of the water there and the frequent heavy sea make it difficult to trawl successfully on that ground." From the latest statistics in "The Fish Trades Gazette" for 1889, Jan. 12th and 26th, we learn that the quantities of Turbot caught by English fishermen or brought to English harbours during the years 1887 and 1888 was:

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[a] Another, less intricate ramification of the lateral line at this point is described by Kroyer, *Danm. Fiske*, vol. 2, p. 436.

[b] *Fish. Brit. Isl.*, pl. CLXI.

[c] *Finl. Fiskar*, pl. XXII.

[d] Sundevall, l. c., p. 165.

[e] *Fauna baltica*, p. 117.

[f] *Fish., Fischer., Fischz. W. u. O. Preuss.*, p. 95.

	1887		1888	
	Cwts	£	Cwts	£
England............ .	63.166	184.662	55.020	175.101
Scotland	5.285	14.425	5.422	16.311
Ireland[d]	—	—	1.211	4.260
Total			61.653	195.672

In the Mediterranean too, the Turbot is common and in great request[e], and is said there to be largest in the Adriatic Sea.

The Turbot, at least at certain seasons, prefers a sandy bottom, pure or mixed with mud. Those spots in the English Channel and the North Sea where it is most abundant, are of this nature, in from 40 or 50 to 10 fathoms of water. But according to Couch it seems to be a migratory fish which moves very swiftly in small shoals and is sometimes to be found at the surface. We learn from France[f] that the best Turbot are taken with hook and line on a rocky bottom. The nature of the bottom preferred by the Turbot may thus vary considerably. Like most other large fishes, the Turbot retires in winter to deeper water and ascends in spring to shallower spots. From the Dutch fishery it also appears that in the North Sea, during spring and summer, the Turbot moves from the south in a northward direction. The Dutch fishermen begin[g] their Turbot-fishery about the end of March, just south of Scheveningen, but gradually move northwards, reaching Heligoland at the beginning of June, and fishing there to the middle of August, when the fishery generally closes for the season. Kroyer quotes an observation of the Danish fishermen off Möen to the effect that in spring the Turbot comes close in shore. With regard to the fishery in Bohuslän Malm makes almost the same remark, with the addition that "small specimens about 150 mm. long are not unfrequently taken in the seine at a depth of from 3 to 6 fathoms, at the head of the fjords, in places where the bottom is of a suitable nature."

The food of the Turbot is composed principally of fish, crustaceans, and mollusks. Olsson[h] found in the stomach of a full-grown Turbot a large Haddock, and in a young specimen a small Plaice, Sand-eels, Pipe-fishes (*Syngnathi*) and examples of the Freckled Goby (*Gobius minutus*). Day states that he found a mixture of crabs, shrimps, and starfish in the stomach of a Turbot. Thus the Turbot seems to be no dainty eater; but it is very particular as to the quality of the bait used for it. This must be perfectly fresh, and consist of a bit of Herring, Sand-eel, or Mackerel, or, still better, a Lamprey. The Turbot is often taken on bulters or hand-lines with bait of this description or, at a pinch, with the flesh of a shellfish or an Annelid. In Scandinavia, however, it is caught chiefly in Flounder-nets; and the great fishery in the North Sea is carried on with the trawl.

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[a] See Lilljeborg, l. c., p. 317.

[b] Intern. Fischereiausstell. Berl. 1880, Schwed. Catal., I. 2. tab. 1.

[c] *Deep-Sea-Fish.*, p. 90.

[d] Complete reports from Ireland for the year 1887 are wanting.

[e] Espos. intern. di Pesca in Berlino 1880, Sez. Ital. Catal., p. 98 ([illegible]) and p. 180 ([illegible]).

[f] Blanchère, *Nouv. Dict. Gén. d. Pêches*, p. 807.

[g] Yarr, *Brit. Fish.*, ed. 2, vol. II, p. 325.

[h] *Iaktt. skand. fisk. föda.* Lunds Univ. Arsskrift, tom. VIII (1871), p. 10 (sep.).

In Sweden, according to NILSSON and MALM, the Turbot spawns in May and June. Mr. C. A. HANSSON has forwarded to the Royal Museum from Strömstad a young specimen 18 mm. long, with the wandering eye exactly at the bridge of the snout, that was taken on the 20th of June, 1882. This specimen was probably at least a month old. DAY mentions a specimen taken on the 20th of August, about 38 mm. long, but at the same point in the course of development, the age of which he supposes to have been two months. The Turbot is enormously prolific. BUCKLAND[a] estimated the number of the eggs in a female 23 lbs. in weight and with ovaries weighing 5 lbs. 9 oz., at 14,311,200. COLLETT computed their number to be 1,056,000 in a female 775 mm. long, whose ovaries weighed 0·52 kgm. This fecundity is well needed if the species is to survive the war of extermination with which it is threatened by the trawl. The Turbot too, has always been sought after more than most other fishes that do not occur in immense shoals, on account of its great value as human food.

The flesh of the Turbot is white, firm (flaky) and of good flavour. In flavour it is perhaps inferior to the Sole—"*de gustibus non disputandum*"—but the large quantity of flesh which it yields, gives it a much greater value. Its proper place is beside the Salmon, if we may compare these two species when properly prepared and eaten with suitable sauces. Like the Salmon and the Halibut, the Turbot is best when boiled. In France, according to MOREAU, it is still called Sea-pheasant (*faisan d'eau*); and in 1770, according to DAY, it was known by this name in Dublin. Even the ancient Romans had conceded to the Turbot the same high rank among fish as that occupied by the pheasant among fowl, and this comparison has endured to our time. The Romans, however, set large Turbot highest, while we prefer those of average size. JUVENAL tells us that the Emperor DOMITIAN called together the Senate to deliberate how a Turbot of wonderful size should be boiled.

As appears from the statistics given above of the amount and value of the Turbot taken by English fishermen during the year 1888, the average wholesale price of Turbot per lb. in England is $6^3/_4$ d. According to NINNI (Catalogue of the Italian Exhibition, Berlin 1880, p. 180), the Turbot in Venice commands a price of about $1^1/_2$ francs per kgrm. (about $6^1/_2$ d. per lb.) for small fish, and as much as 4 francs per kgrm. (17d. per lb.) for large ones. "In Gothenburg," says MALM, "it is much in demand among the wealthy, and during the thirty years I have lived there, the price of a large Turbot, about 2 ft. long[b], has gradually risen from 3—5 to 18—25 crowns (3s. 4d.—5s. 7d. to £1—£1 8s.)." The value of the Turbot is considerably enhanced by the circumstance that it can be kept fresh comparatively long. It is also fairly tenacious of life. KRØYER states that when the Danish fishermen of the Cattegat take a large Turbot and cannot immediately find a purchaser for the valuable catch, they tie a line round its tail or pass one through its mouth and gill-openings, and fasten it to a stone or stake on the beach. Thus prevented from escaping, the Turbot can live some time in rather shallow water, if the weather is not too warm. "The manner," adds KRØYER, "in which the Turbot is kept alive in the well-boats, puts its tenacity of life, in my opinion, to a still harder test. With a cord passed through the mouth and gill-openings it is hung straight up and down in the well-stowage, fastened to the deck-beams. This is done because it is impossible to let the Turbot lie among the other Flatfishes, for it would then damage its companions with its sharp spinous tubercles, especially when the boat is beating up against the wind or is in a heavy sea."

In Scandinavia the Turbot is taken principally in April and May and from August to October inclusive. During the spawning-season itself (May and June) most of these fish are of course lean and flabby; but the Turbot is voracious enough soon to regain its former condition. It is considered best from September to April inclusive. According to YARRELL the English actor QUIN, of epicurean notoriety, was the first to discover that the flesh of the Turbot is best on the eye side, where it is also thickest. For this reason English consumers set most value on "double" Turbots, i. e. those which are coloured on both sides.

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[a] *Nat. Hist. Brit. Fish.*, p 183.

[b] About 6 kgrm. in weight.

In Sweden the Turbot is known by many names. The Scanians say *piggvarr* or *pifvare* (cf. the Danish *pigvarr*); on Gothland and in the island-belt of Stockholm it is called *Butta*, *Botta* or *Potta* (cf. the German *Butte*). Just as the Germans also call the Turbot *Steinbutt*, in Södermanland, according to Ekström, it is known as *Stenflundra*, and in Stockholm, according to Malm, as *Stenpotta*. *Pigghvarf* or *Pigghvarfvel* (Spiny Fluke) is the name given it in Bohuslän.

THE BRILL (SW. SLÄTHVARFVEN.)

BOTHUS RHOMBUS.

Plate XVIII, fig. 2.

Greatest depth of the body less than 50 %[a], length of the head less than 27 %, postorbital length of the head less than 16 %, length of the maxillary bone of the eye side less than 12 %, length of the branch of the lower jaw on the blind side less than 15 %, distance between the anal fin and the tip of the snout less than 27 %, base of the left ventral fin less than 10 %, base of the right ventral fin and the greatest thickness of the body less than 8 %, of the length of the body. First rays of the dorsal fin repeatedly divided into lobate branches. Number of rays in the dorsal fin more than 70, in the anal fin more than 50. Least depth of the tail more than 20 %, and the length of the caudal fin at the middle at least 36 %, of the greatest depth of the body. Body covered with small, but firmly attached scales.

R. br. 7; *D.* 73—80[b]; *A.* 54—61[c]; *P.* 11 l. 12; *V.* 6; *C.* $x+13$ l. $14+x$; *Lin. lat.* ca 120[d]; *Vert.* 35—36.

Syn. *Rhombus lævis*, Rondel., *De Pisc.*, lib. XI, cap. III; Lin. (*Pleuronectes*), *It. Wgot.*, p. 178 (nom. a Linnæo ante *Syst. Nat.* X. datum, postea rejectum); Gottsche (*Rhombus*), Wiegm. Arch. Naturg. I, 2 (1835), p. 175; Bonap., *Fn. Ital.*, III, *Pesc.*, tab. No. 99, fig. 2; Nilss., *Skand. Fn.*, *Fisk.*, p. 638; Gthr, *Cat. Brit. Mus.*, *Fish.*, vol. IV, p. 410; Steind., Stzber. Akad. Wiss. Wien, Math. Naturw. Cl., LVII, I (1868) p. 714; Coll., Forh. Vid. Selsk. Christ. 1874, Tillægsh., p. 137; Winth., Naturh. Tidskr. Kbhvn, ser. 3, vol. XII, p. 37; Ninni, Espos. Intern. Pesc. Berl. 1880, Sez. Ital., Cat., p. 180; Mor., *Hist. Nat. Poiss. Fr.*, tom. III, p. 340; Day, *Fish. Gt Brit.*, *Irel.*, vol. II, p. 14, tab. XCVII; Möb., Hcke, *Fish. Osts.*, p. 90.

Pleuronectes Rhombus, Lin., *Syst. Nat.*, ed. X, tom. 1, p. 271; Retz., *Fn. Suec. Lin.*, p. 332; Qvens., Vet.-Akad. Handl. 1806, p. 54 et 207; Nilss., *Prodr. Ichth. Scand.*, p. 59; Schagerstr., Physiog. Sällsk. Tidsk., 1837, p. 312; Ekstr., Gbgs Vet., Vitt. Samh. Handl., N. T., H. 1 (1850) p. 40; Thomps., *Nat. Hist. Irel.*, vol. IV, p. 201; Jord., Gilb. (*Bothus*), Proc. U. S. Nat. Mus. 1882, p. 577; Lillj., *Sv.*, *Norg. Fisk.*, vol. II, p. 319.

Pleuronectes passer, Gronov.; *Pl. cristatus*, Licht.; *Pl. lædermа*, Nardo; *Bothus rumolo*, Rafin., *Rhombus barbatus*, Risso; *Pleuronectes pavonina*, Costa: — vide Gthr et Day, ll.cc.

The Brill and the Turbot are as closely related to each other as the Plaice and the Flounder — to choose one of the most prominent examples among the many that we might select from the preceding part of this work. In the great majority of the characters, too, the differences are parallel, so that in the following table we constantly find the percentage higher or lower in the Brill than in the Turbot, in exactly those characters in which we find a similar difference between the Plaice and the Flounder (cf. the above table, p. 407.)

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[a] In very old (large) specimens, however, the percentage may be greater.

[b] According to Gottsche 67—83.

[c] According to Gottsche and Day 50—63.

[d] In two specimens 118 and 126 respectively, the former with about 30 additional scales on the caudal fin, the latter with about 20.

Average in	*Bothus rhombus* 5 specimens.	*Bothus maximus* 4 specimens.
Length of the body expressed in millimetres	151	163
„ „ „ head in % of the length of the body	26.0	28.9
Greatest depth of the body „ „ „ „ „ „ „ „	46.2	58.4
Least „ „ „ „ „ „ „ „ „ „ „ „	10.6	10.4
Postorbital length of the head „ „ „ „ „ „ „ „	15.4	17.7
Length of the lower jaw on the eye side „ „ „ „ „ „ „ „	14.0	15.3
„ „ „ „ „ „ „ blind „ „ „ „ „ „ „ „ „	14.1	15.6
„ „ „ base of the dorsal fin „ „ „ „ „ „ „ „	76.3	72.8
„ „ „ „ „ „ anal „ „ „ „ „ „ „ „ „	60.5	58.6
„ „ „ longest ray in the dorsal fin „ „ „ „ „ „ „ „	11.0	12.9
„ „ „ „ „ „ „ anal „ „ „ „ „ „ „ „ „	11.4	13.1
Distance between the anal fin and the tip of the snout „ „ „ „ „ „ „ „	25.6	34.4
Length of the pectoral fin of the eye side „ „ „ „ „ „ „ „	11.8	12.4

It is only in the length (height) of the ventral fin of the eye side and the length of the middle rays of the caudal fin that the averages in the Scandinavian Brill and Turbot run in the opposite direction to the difference which the table on p. 407 shows between the Plaice and the Flounder. The average length of the longest ray in the ventral fin of the eye side, expressed in percent of the length of the body, has proved in the Scandinavian Brill to be 7·5, in the Scandinavian Turbot 7·7, while the corresponding average length of the middle rays of the caudal fin is 17·5 in the Brill and 19 in the Turbot. The ventral fins are also smaller in all respects in the Brill than in the Turbot, the average length of the base of the ventral fin, expressed in percent of the length of the body, in the specimens of the Brill included in the above table, being 9·1 on the eye side and 7·4 on the blind side, while the corresponding percentages in the specimens of the Turbot included in the above table are respectively 11·1 and 8·9.

To this comparison we may also add that, just as the Plaice has more vertebræ and more rays in the dorsal and anal fins than the Flounder, the Brill also surpasses the Turbot in these respects. And just as the Plaice generally has only cycloid scales, while the Flounder is distinguished by its spinous warts, the Brill is furnished with cycloid scales, thin, small and imbricated on both sides of the body, on the rays of the vertical fins, and on part of the rays of the left pectoral fin, while the Turbot, as we have mentioned, is without these scales, but has its spinous tubercles.

In other respects, however, these two species are so like each other that no detailed description of the Brill can be necessary. Still, the Brill is much thinner and of a more elliptical form. The greatest thickness of the body, which occurs in the anterior part of the abdominal region, seems never to exceed 8 % of the length of the body: in young specimens, between 9 and 11 cm. long, we have found this percentage to vary between 7·8 and 7·2, while in more adult specimens, up to a length of 22 cm., it has varied between 6·6 and 6·4. Another, more important characteristic appears in the anterior rays of the dorsal fin, the anal fin, and the ventral fin of the eye side. The first rays of the dorsal fin, in full-grown specimens back to the fifth ray, are deeply and repeatedly branched, the first and second rays being also usually longer than those immediately following them, which gradually diminish in length until at the fifth or sixth ray — in old specimens at the seventh ray — they again begin by little and little to increase in length[a]. The first, multifid rays also project beyond the true fin-membrane, sometimes to half their length, but are themselves furnished with a small, membranous flap along the anterior and posterior margins, thus acquiring a flat, lobate appearance. The remainder of the dorsal fin[b] is composed of more or less distinctly bifid rays, their tips above the fin-membrane growing gradually shorter behind. The greatest height (longest ray) of the dorsal fin occurs between the 35th and 50th rays. Its beginning lies further forward on the snout than in the Turbot, a point that is best illustrated by the circumstance that the anterior nostril of the blind side, which in the Turbot is in a line with the first ray of this fin, here lies in a line with the third ray. The structure of the anal fin is, as usual, essentially the same as that of the dorsal fin; but the above remarks as to the ramification of the rays are valid here only in exceptional cases and even then apply only to the very first ray, which is also not elongated. The anal fin is highest between the 21st and 29th rays. Both the dorsal and the anal fins keep to the dorsal edge posteriorly, but end distinctly nearer the blind side.

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[a] The anterior part of the dorsal fin is very frequently elevated in the preceding genus.

[b] The anterior rays of the dorsal fin, in adult specimens back to at least the 25th ray (as in the preceding species), are furnished on the blind side of the body with a thin, raised, membranous margin.

The coloration of the eye side is also very variable in the Brill. It is generally grayish brown or greenish, with dark, undefined spots on a lighter or darker ground, and with dark, smaller spots and dots or ocellated spots or plain, lighter, whitish yellow ones, arranged as in most specimens of the Plaice, in one row along the base of the dorsal fin, in another along that of the anal fin, and scattered over the body and fins, especially the caudal. Sometimes the eye side is entirely black, with a few white spots on the anal fin (COUCH). The spots on the fin-rays are especially distinct on the anterior rays of the dorsal fin. There they form handsome, narrow, transverse bands on the rays, giving them the appearance of fine, small blades of seaweed.

In Scandinavia at least, the Brill never attains even the ordinary size of the Turbot. A Brill 60 cm. long is exceptionally large. According to KRØYER, however, it is sometimes about 30 Danish inches (78 cm.) in length. Bearing in mind that a Brill 575 mm. long weighs 8 Danish pounds (4 kgm.), we must conclude that this species attains a much larger size in the Mediterranean, where, according to RISSO[a], specimens 8 kgm. in weight are taken.

In its manner of life and geographical range the Brill resembles the preceding species, but probably does not go so far north[b] and also does not penetrate so far into the Baltic, being hardly found east of Scania and Mecklenburg. Off Bornholm it is unknown[c]; BENECKE does not include it among the fishes of the Prussian coast, nor SEIDLITZ among those of the Baltic Provinces of Russia; and a statement made long ago by FISCHER (1777), to the effect that it occurs in the Gulf of Finland, thus seems very dubious. In the south of the Sound it is fairly rare, but further north, in the Cattegat and Skager Rack, it is about as common as the Turbot. In the North Sea and further south in the Atlantic it is still more common[d], as well as in the Mediterranean and the Adriatic; but there is no record of its occurrence in the Black Sea. It is no less voracious than the Turbot, and lives chiefly on fish and crustaceans, but does not take a hook so readily. In Scandinavia it is taken principally in Flounder-nets, and in the North Sea by trawling. On the coast of Bohuslän, on the 20th of May, 1857, MALM found a female with running roe. Hence it seems that it spawns at the same time of year as the Turbot. It should thus be best for table in winter, but then it is generally scarcer, probable because at this season it seeks deeper water; and in summer, when it is most plentiful, the flesh is naturally more flabby after the spawning, and often infested with worms. This is the cause of its ill-repute, and not even in its best condition can it rank with the Turbot; but it is by no means to be despised, being at least as good as the Plaice. On his travels in Spain and Portugal STEINDACHNER observed that on the Spanish Peninsula the Brill is not inferior to the Turbot either in size or in delicacy of flavour. In England, on the other hand, it is so little esteemed that its price is not separately quoted in the London fish-market, an honour of which both the Plaice and the Dory are considered worthy.

Släthvarf or *Släthvarfvel* (Smooth Fluke) is the ordinary name of the Brill in Bohuslän, though on Sydkoster, according to MALM, it is called *Sandhvarf*. "At Abekås," says NILSSON, "it is believed to be a hybrid between the Turbot, which it resembles in shape, and the Plaice, from which it is supposed to derive its smooth skin. Hence it is usually called *Horunge* (Bastard), and is known to every fisherman by this name. Some call it *Slättvar*."

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[a] *Ichthyologie de Nice*, p. 316.

[b] KROYER assumes that the northern limit of the range of the Brill lies between Lat. 61° and 62°, i. e. in the neighbourhood of Bergen.

[c] See WINTHER, l. c.

[d] The Brill, like many other Flatfishes, sometimes ascends rivers. "Because it enters the Elbe more often than other Flatfishes," says BLOCH (*Fische Deutschlands*, II, p. 38), "the inhabitants of Hamburg have conferred upon it the name of *Elbbutt*."

The relation between the Turbot and the Brill is further illustrated by the form which has received of Malm the specific name of *hybridus*. We have already remarked the existence of hybrids of the Turbot and Brill. Quelch states[a] that such specimens are taken in spring on the Dutch coast, but that they are fairly rare. "They resemble the turbot in shape, but the head is like the brill. They have neither the spiny protuberances of the turbot nor the scales of the brill, but are thickly covered with small horny plates, a sort of compromise between the two." Moreau's variety of the Brill from the Mediterranean (l. c., p. 342) is also an intermediate form, which may most naturally be explained on the assumption of hybridism. In this form not only are the anterior rays of the dorsal fin less ramified than in the typical Brill, but the length of the upper jaw, according to Moreau's measurements, is also more than 12 % of the length of the body, a character which we have invariably found to belong to the Turbot[b]. A number of intermediate forms, varying in their degrees of resemblance, one more like the Turbot and another more like the Brill, may thus be assumed to exist; and at least two have been met with within the limits of the Scandinavian fauna.

THE BRILL-LIKE TURBOT. BOTHUS MAXIMUS HYBRIDUS.

Fig. 113.

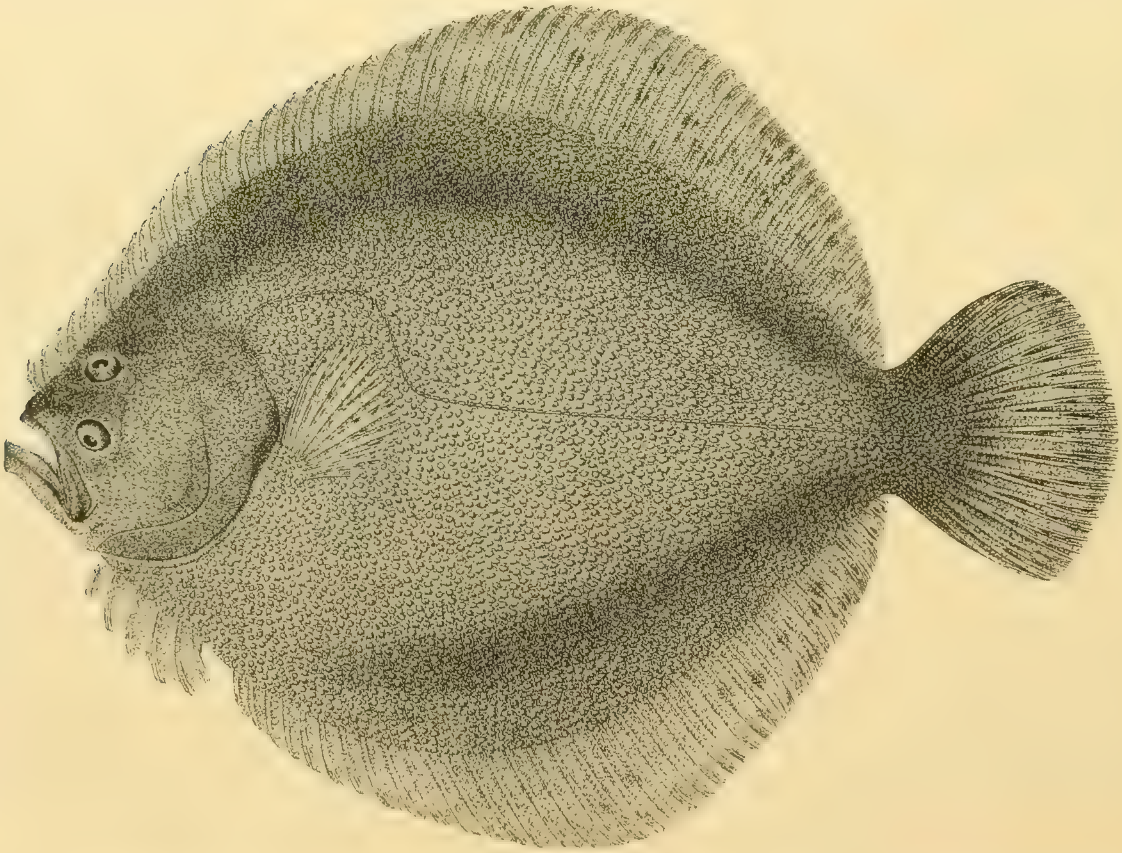

Fig. 113. *Bothus maximus hybridus*, ♂, $^2/_5$ of the natural size. Taken at a depth of 20 fathoms in Strömstad Fjord, on the 21st of May, 1887, by C. A. Hansson.

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[a] Proc. Zool. Soc. Lond. 1869, p. 473.

[b] Ekström's description of the Baltic Turbot with 69 rays in the dorsal fin and 49 in the anal can hardly be explained in this manner, for the Brill has never been met with so far up the Baltic.

This form is described at length by Malm (*Gbgs. Boh. Fn.*, p. 511). He possessed two specimens, both females and both taken off the Skaw, the one, 56 cm. long, in April, 1871, and the other, 62 cm. long, in November, 1880. A third specimen, a male 38 cm. long, was caught by Mr. C. A. Hansson in Strömstad Fjord, on the 21st of May, 1887, and forwarded by him to the Royal Museum.

Relatively to the length of the body the greatest depth is more than 50 %, the total length of the head less than 27 %, the postorbital length of the head less than 17 %, the length of the maxillary bones less than 12 %, the length of the right branch of the lower jaw less than 15 %, the distance between the anal fin and the tip of the snout less than 30 %, the base of the left ventral fin more than 10 %, that of the right ventral fin more than 8 %, and the greatest thickness of the body less than 8 %. First ray of the dorsal fin deeply and repeatedly branched. Number of rays in the dorsal fin less than 70, in the anal fin less than 50. Least depth of the tail less than 20 %, median length of the caudal fin less than 36 % of the greatest depth of the body. Body furnished with fairly dense, thickened, oval, tubercular scales, more or less covered by skin, each with a low and blunt protuberance behind, and with a groove running forward from this protuberance. Curved (abdominal) part of the lateral line high and short, the height of the curve being about half its length, which measures about $^3/_4$ of the length of the middle rays of the caudal fin. Length of the base of the dorsal fin, measured in a straight line, more than 75 %, of the anal fin, measured in the same manner, more than 60 %, of the length of the body. Each of the rays of the vertical fins furnished with a double row of scales, the posterior row containing almost typical cycloid scales, like those of the Brill, excepting that the nucleus in the outer (posterior) part of the scale is slightly raised into a buckle.

The fin-formula in the specimens on record is:

D. 63—65; *A.* 47—48; *P.* 12[a]; *V.* 6[b]; *C.* 2[c]+13[d]+2[c].

The lateral line of the eye side contains 34[e]—36 scales in the arch and 51[e]—60 in the straight part, or 85—96 scales in all. On the blind side we have found 37 scales in the arch and 71 in the straight part of the lateral line.

Malm's specimens were brownish, with a slight dash of olive-gray, on the eye side; Hansson's specimen, when it reached the Museum, was of an almost plain blackish brown. The blind side is white.

THE TURBOT-LIKE BRILL — BOTHUS RHOMBUS HYBRIDUS.

Fig. 114.

Mr. Hansson has forwarded to the Royal Museum a male specimen of this form, 33 cm. long, that was taken in Strömstad Fjord on the 10th of May, 1889.

In this specimen the fin-formula is:

D. 68; *A.* 52; *P.* 12; *V.* 6; *C.* 2+13+2.

The scales of the lateral line are so indistinct that they can scarcely be counted with certainty. I believe there were 106 opening pores back to the base of the caudal fin on the eye side, and 118 on the blind side, of these 44 in the arch on the former side and 48 on the latter.

As in the preceding form the body resembles that of the Turbot in one respect: the greatest depth of the body is more than half the length. But the least depth of the body (tail) is somewhat more than $^1/_5$ (nearly 22 %) of the greatest depth, a character which gives this form a resemblance to the Brill. Furthermore, the first rays in the dorsal fin branch still more like those of the Brill; the anal fin contains more than 50 rays; the base of the ventral fin of the eye side measures less than $^1/_{10}$ of the length of the body; the scales are still more nearly of the typical cycloid form, being only slightly thickened, entirely covered with skin, and with a scarcely perceptible buckle, which externally appears like a small tubercle, and from which the groove in the scale runs in a forward direction. The anterior bend of the lateral line is comparatively low and long, as in the Brill, its height above the line from the beginning of the lateral line behind the temporal region to the beginning of the straight part, is about a third of the length of this line, which in this form as in the Brill is equal to, or even greater than, the length of the middle rays of the caudal fin. In the other points that we remarked in the preceding form as characteristic of the Brill, this form resembles the preceding one; but as in the Turbot and the preceding form the base of the ventral fin on the blind side is more than 8 % of the length of the body.

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[a] According to Malm 10.

[b] " " " 7.

[c] These rays (the two outermost at the upper and lower margins of the caudal fin) do not extend to the hind margin of the fin, and the inner one on each side is branched (bifid). This is also true of the following form.

[d] According to Malm 14.

[e] According to Malm.

Fig. 114.

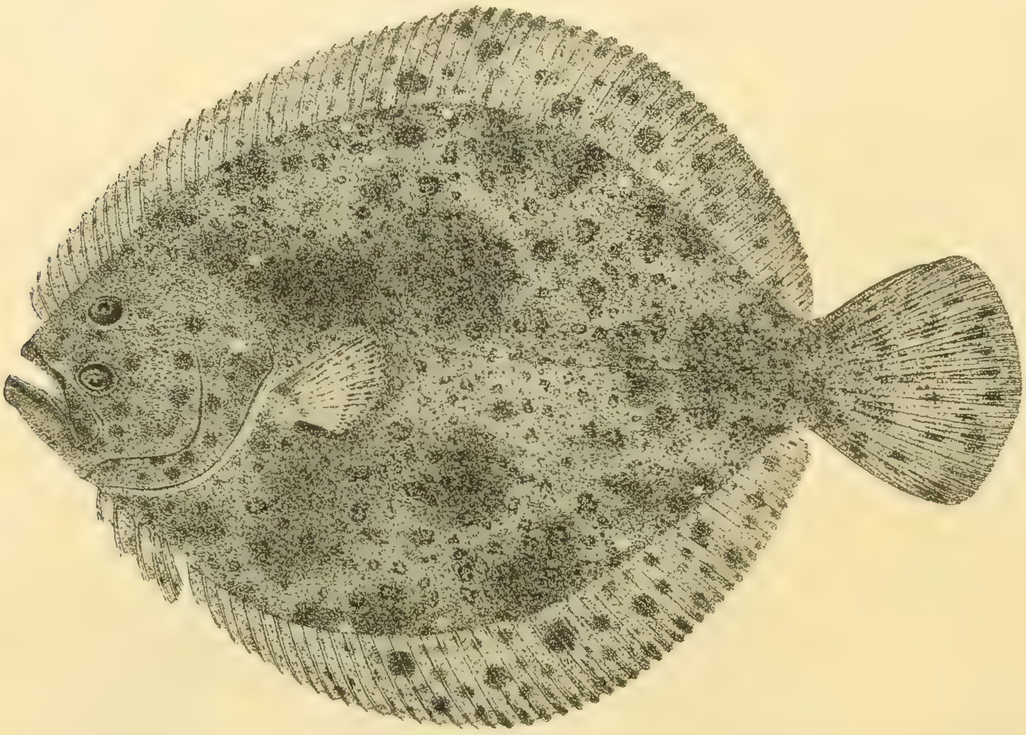

Fig. 114. *Bothus rhombus hybridus*, ♂, $^2/_5$ af the natural size. Taken in Strömstad Fjord, on the 10th of May, 1889, by C. A. Hansson.

The coloration of the Turbot-like Brill is olive-gray, with blackish brown, ocellated or simple spots on the body and the vertical fins, almost as in v. Wright's figure of the Brill, though the large clouded spots are more indistinct. The white spots at the bases of the dorsal and anal fins, as well as on the lateral line and the operculum, are also preserved in this form.

In whatever way we choose to explain these two forms — whether as hybrids, which seems most likely, or as varieties of another signification — they show such an intermingling of the characters of the Turbot with those of the Brill that we can hardly regard these two chief species of the genus as widely separate.

GENUS LEPIDORHOMBUS.

Jaw-teeth of uniform size (no canines), pointed, recurred, small, and set in a card on the front part of the intermaxillary bones and of the lower jaw. Head of the vomer also furnished with small teeth, but the palatine bones and tongue smooth. Lower pharyngeal teeth set in several rows (cardiform). Most of the fin-rays branched. Branchiostegal membranes partially united below, but further back meeting in different planes, the one crossing the other. Branchiostegal rays 7. Middle wall of the branchiostegal cavity pierced above the urohyoid bone by a large hole. Ventral fins free from the anal fin. Scales on the eye side of the body ciliated at the hind margin, on the blind side smooth-margined. Anal spine and preanal spines wanting. Distance between the anal fin and the tip of the snout greater than the length of the head or only slightly less than it.

The following three genera, which were long combined, not unnaturally, with the preceding genus — so close is the connexion between them — are characterized in the first place by the peculiarity pointed out first by STEENSTRUP[a], that the median wall between the two branchial cavities is broken below the branchial arches and the lower pharyngeals. But they also deviate more than any other of the Bothoids from the symmetrical piscine type, in the transference of the posterior parts of the dorsal and anal fins to the blind side. We have already observed a slight tendency in this direction in the case of the Brill; but here this asymmetry is more and more developed till it culminates in the termination of these fins by a distinct lobe on the blind side.

The genus *Lepidorhombus*[b] resembles *Bothus* in the dentition of the head of the vomer and the separation of the ventral fins from the anal fin; but, apart from the division of the wall of the branchial cavity, is of an entirely different form of body. The body is more elongated, narrow, and thin, the greatest height of the dorsal and anal fins being situated further back. The scales, too, are more plentiful and larger, but thin and, on the eye side, ciliated at the hind margin. Like the following genera, too, but in a still higher degree, *Lepidorhombus* is distinguished from *Bothus* by the shallower peduncle of the tail, the least depth of the body, which in *Bothus* is at least about 10 % of the length of the body, being at most about 7 % thereof in *Lepidorhombus*. This genus differs from the two following genera, apart from the characters given above, chiefly in the large size of the gape. Even the branch of the lower jaw on the blind side, which is somewhat shorter than that on the eye side, measures distinctly more than half the length of the head, in adult specimens at least about 55 % thereof; while in the following genera this proportion is at most a little less than 50 %.

The genus *Lepidorhombus* has been divided into three species, all belonging to European waters: *Lepidorh. Boscii*[c], belonging to the Mediterranean, with elongated body and large, deciduous scales, and with fewer rays in the dorsal fin (75—82) and the anal (62—66); *Lepidorh. whiff* (*megastoma*), belonging to the Mediterranean, where it is known by the name of *Cardine*, and the Atlantic outside, up to the south of Great Britain and Ireland, where it bears the names of *Whiff* and *Carter*, with elongated body, the greatest depth being less than $^1/_3$ of the length, and more numerous and more firmly attached scales; and the more northern *Lepidorh. velivolans*, with deeper body than the latter. GIGLIOLI, however, proposed, according to DAY, to unite these forms into one single species; and the opinion most generally current at present, and probably the correct one, is that at least the last two forms should be regarded as one species.

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[a] Overs. Dske Vid. Selsk. Forh. 1865, p. 100.

[b] GÜNTHER, subgenus, *Cat. Brit. Mus., Fish.*, vol. IV. p. 407.

[c] *Pleuronectes Boscii*. RISSO, *Ichth. Nice*, p. 319, pl. VII. fig. 33; BONAP. *Fn. Ital.*, III. tav. No. 97, fig. 2.

THE WHIFF (SW. GLASHVARFVEN[a]).

LEPIDORHOMBUS WHIFF.

Fig. 115.

Greatest depth of the body less than 40 %, total length of the head less than 25 %, length of the head behind the lower eye less than 14 %, maxillary bone of the eye side more than 10 %, maxillary bone of the blind side more than 9 %, branches of the lower jaw more than 13 %, pectoral fin of the blind side less than 7 %, base of the dorsal fin (measured in a straight line) less than 75 %, its greatest height (longest ray — about the 54th or 55th) less than 9 %, base of the anal fin less than 60 %, its greatest height (about the 42nd ray) less than 9 %, distance between the anal fin and the tip of the snout more than 25 %, length of the middle caudal rays measured from the hind limit of the scales of the body less than $14^{1}/_{2}$ %, greatest thickness of the body less than 6 %, of the length of the body. Length of the pectoral fin of the blind side less than $^{1}/_{2}$ that of the lower jaw, and the length of the middle caudal rays less than that of the lower jaw, but more than $^{1}/_{2}$ that of the head. Least depth of the tail more than 17 % of the greatest depth of the body.

R. br. 7; *D.* 85—91; *A.* 67—75; *P.* sin. 11 l. 12, dextr. 9 l. 10; *V.* 6; *C.* 2 + 13 + 2; *Lin. lat.* 110—125; *Vert.* 41.

Syn. *Whiff*, PENN., *Brit. Zool.* (1776), III, p. 209; *Pleuronectes whiff*, WALB., *Ichth. Art.*, III, p. 120; JORD., GOSS (*Lepidorhombus*), Rep. Comm. Fish., Fisher. 1886, p. 252.

Pleuronectes megastoma, DONOVAN, *Brit. Fish.*, vol. III, pl. 51; YARR. (*Rhombus*), *Brit. Fish.*, ed. 2, vol. II, p. 342; DÜB., KOR., Vet.-Akad. Handl., 1844, p. 102; NILSS., *Skand. Fn.*, *Fisk.*, p. 641; GTHR, *Cat. Brit. Mus.*, *Fish.*, vol. IV, p. 411; COUCH, *Fish*, *Brit. Isl.*, vol. III, p. 167, tab. CLXIV; COLL. (*Zeugopterus*), Forh. Vid. Selsk. Christ. 1874, Tillægsh., p. 138; ibid. 1879, No. 1, p. 76; (*Lepidorhombus*), N. Mag. Naturv. Christ., Bd. 29 (1884), p. 100; MALM (*Rhombus*), *Gbgs*, *Boh. Fn.*, p. 516; MOREAU (*Pleuronectes*), *Hist. Nat. Poiss. Fr.*, tom. III, p. 332; DAY (*Arnoglossus*), *Fish. Gt. Brit.*, *Irel.*, vol. II, p. 21, tab. XCVIII; LILLJ. (*Zeugopterus*), *Sv.*, *Norg. Fn.*, *Fisk.*, vol. II, p. 341.

Zeugopterus ? velivolans, RICHARDS. in YARR., *Brit. Fish.*, ed. 2, vol. II, suppl. 2, p. 1; COUCH, l. c., p. 163, tab. CLXIII.

The Whiff attains a length of at least about 6 dm.[b] The body is as elongated as that of the Pole, but far thinner, being so thin and transparent, according to v. DÜBEN and KOREN, that "when a fresh specimen is held towards the light, the bones and viscera are distinctly visible." The body is deepest somewhat behind the middle point of the distance between the tip of the snout and the beginning of the peduncle (finless part) of the tail on the eye side, and in old specimens, more than 5 dm. long, measures rather less than half this distance, or about half the base of the dorsal fin, measured in a straight line. In younger specimens, up to a length of about 4 dm., this depth is even relatively less, being not even equal to the distance between the tip of the snout and the end of the curved anterior part of the lateral line. This species is also recognisable at the first glance by the very projecting tip of the lower jaw with its well-developed chin-knob, and by the comparatively long snout. The distance between the tip of the snout and the anterior margin of the lower orbit is equal to the longitudinal diameter of this orbit, which is by no means inconsiderable, or to the distance from the posterior margin thereof to the hind margin of the preoperculum. The length of the lower jaw is greater than that of the head behind the lower eye. The sides of the tip of the snout are remarkable for their unevenness, which is caused partly by the anterior (upper) end of the maxillary bone, and partly (on the eye side) by the outer (upper anterior) articular process of the palatine bone. Just behind the articulation of the maxillary bone, and protruding still more than in the true Bothoids, rises the lobate process of this bone that we have noticed above in the Turbot. When the mouth is closed, the tips of the nasal processes of the intermaxillary bones form a swelling that gives the upper edge of the snout a depressed (concave) shape at the beginning of the dorsal fin. On the other hand, when the mouth is open, and the intermaxillary bones protruded, the profile of the snout is almost straight and runs in a straight line with the even slope (only slightly curved) of the anterior part of the dorsal edge of the body. The eyes, though they do not entirely fill the orbits, are fairly large, their longitudinal diameter in full-grown specimens, more than 35 cm. long, measuring from $^2/_5$ to $^1/_3$ of the postorbital length of the head. The dividing wall between them (the narrow frontal bones), a rounded, longitudinal carina, measures at the narrowest spot, in old specimens, between 4 and $5^1/_2$ dm. in length, only $^1/_5$ or scarcely $^1/_4$ of their longitudinal diameter. The operculum and suboperculum are like those of the preceding forms. The sinus in the hind margin is shallow and filled by the branchiostegal membrane. The gill-opening scarcely extends up to a level with the middle of the upper eye, though the upper articulation of the preoperculum occurs here. The preoperculum is obtuse-angled, with rounded corner. The interoperculum is long, a little shorter than the maxillary bones, and of uniform breadth. The mouth is

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[a] MALM, l. c.

[b] COUCH assumes that it attains a length of 23 or 24 in. (58 or 61 cm.). THOMPSON's largest specimen from Ireland was $23^{1}/_{2}$ n. long.

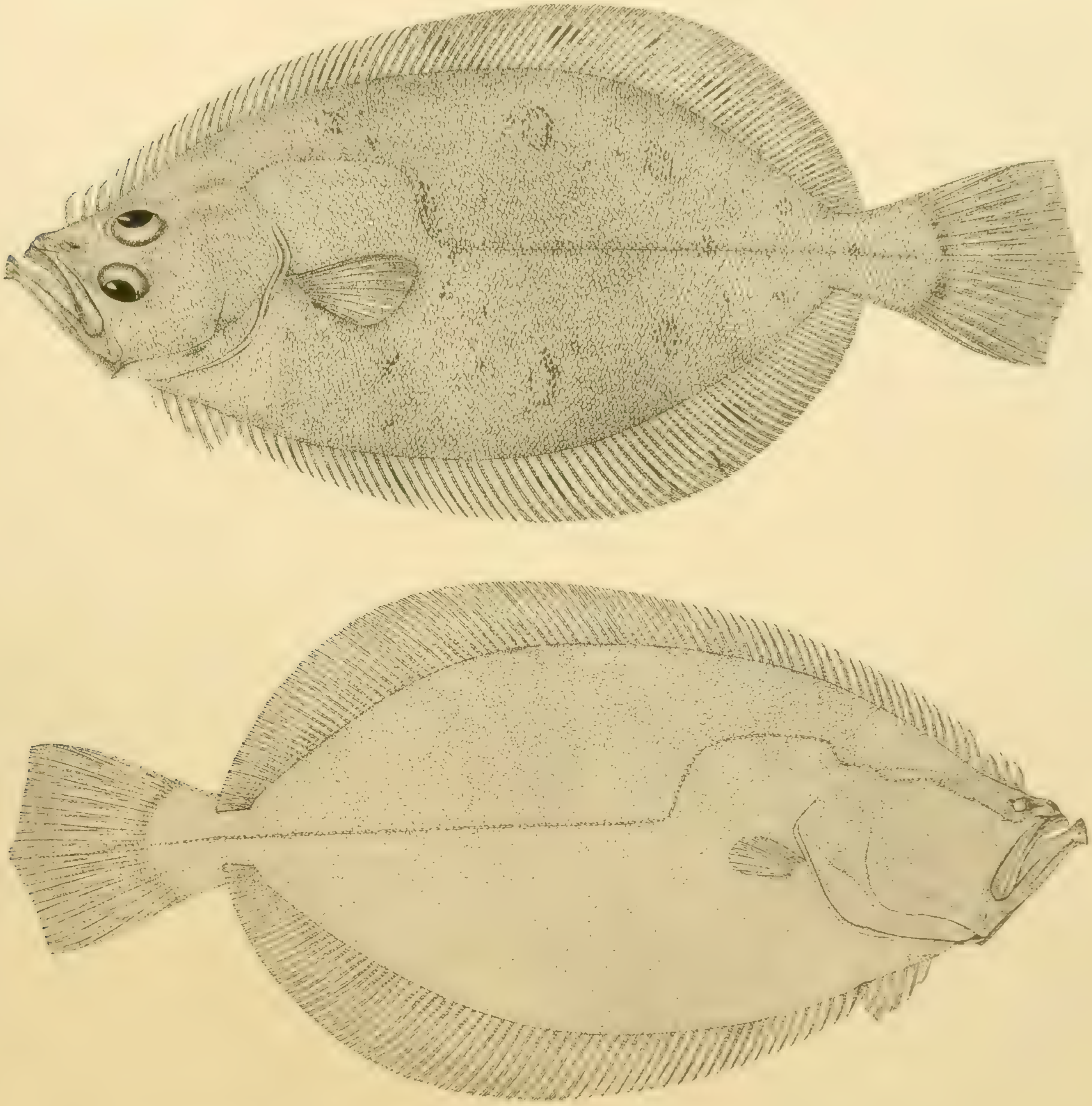

Fig. 115. *Lepidorhombus whiff*, seen from the eye side and from the blind side, $^1/_3$ of the natural size. Specimen taken by Fisherman OLSSON on the fishing-bank of Jäderen in 1874.

obliquely set, being turned upwards at an angle of about forty-five degrees. The teeth are small, pointed, and set in a fairly dense card on the front of the lower jaw — beyond the tip of the snout when the mouth is closed — and on the intermaxillary bones. Each of these cards narrows posteriorly into two rows and finally into one single row. On the head of the vomer the teeth are quite as strong, but fewer, sometimes only 3—6. The inner transverse folds (vela) differ in development in different individuals, but are sometimes fairly broad both in the upper jaw and the lower. The nostrils are of the same form as in the preceding genus, the anterior round, the posterior oblong and set longitudinally. A small process-like flap is set at the front margin of the anterior nostril, which is marked in this species by an extraordinarily large, foliate, rounded flap behind. The position of the nostrils is also essentially the same as in *Bothus*, though they lie farther out on the snout, on the eye side at about its middle; on the blind side the anterior nostril lies vertically below the first ray of the dorsal fin.

Here, too, the anterior rays of the dorsal fin have a broad, membranous margin, but are pointed at the tip and not so deeply branched as in the Brill, the two lateral halves, in the first ray at least, being separated within the obliquely transverse, membranous flap. At least the first four rays may be free from each other for the greater part of their length and united by the fin-membrane only at the base. Most of the other rays, except the last 40, are simple or only indistinctly branched. The posterior rays, with the exception of the last two or three, are multifid at the tip. The posterior ends of the dorsal and anal fins pass over to the blind side, though without forming any distinct lobes there and with the distance between them equal to 80 % of the least depth of the long peduncle of the tail. In the anal fin the structure of the dorsal fin is repeated, only that most of the rays are distinctly branched and multifid at the tip. The distance between the anal fin and the tip of the snout, in old specimens, measures about 36 % of the length of the body. The distance between this fin, as well as the dorsal, and the middle of the base of the caudal fin is almost equal to the length of the maxillary bones. The convex hind margin of the caudal fin forms a broad obtuse angle at the middle. The ventral fins resemble those of the preceding genus in their relative position to each other and to the beginning of the anal fin; but they are less unlike each other in the length of the base. In younger specimens they do not overlap the beginning of the anal fin, but in older ones they extend along the sides thereof. On account of the elongated form of the body their relative size is less, the length of the base of the left ventral fin being in old specimens about $7^1/_2$ % of the length of the body, of the right ventral fin about $6^1/_2$ % thereof: the height of each of them is about $4^1/_2$ % of the length of the body. The pectoral fins are distinguished from those of the preceding genus by their greater dissimilarity. The pectoral fin of the eye side is of an oblique and rounded, truncate form, the 4th—6th rays being the longest, the 3rd only slightly shorter than they, and the 2nd only $^1/_6$ shorter than the 3rd; the length of the 1st ray is only $^1/_6$ or $^1/_5$ of that of the 2nd. The first and second rays are simple, the first also unarticulated, but the other 9 or 10 are multifid, with the exception of the last ray, which is bifid. The pectoral fin of the blind side is of a pointed, oval form, the 6th ray being the longest, the 1st half as long as the 2nd, which is about equal in length to the last, the 9th or 10th. The first ray of this fin is also simple and unarticulated, the second and sometimes the third articulated, but simple, the others, except the last, bifid. This fin is furnished with thicker skin, but much shorter than the pectoral fin of the eye side, the relative length of both fins diminishing slightly with age, and that of the former measuring about $6^1/_2$ or 6 % of the length of the body, that of the latter about 12 % thereof. The length of the latter fin is also only slightly less than that of the head behind the lower eye.

The scales are thin, but well-imbricated and rather firmly attached. Those of the blind side are smooth-margined, those of the eye side densely ciliated on the little patch behind the nucleus, which is surrounded by dense and fine, circular striæ, with eccentric extensions in a forward direction, while numerous grooves radiate forward from the same point. The whole body, except the snout, is covered with scales. The intermaxillary bones and the greater part (sometimes the whole) of the lower jaw are naked, but on the hind part of the latter, just in front of the articulation, we sometimes find a few small scales. The greater (lower) part of the maxillary bone of the eye side, which is slightly dilated downwards, is also covered with scales. On the blind side the jaw-bones are naked, as well as an oblong longitudinal patch behind the nostrils. All the fin-rays are covered with scales for a greater or less part of their length on the eye side of the body; but this covering grows gradually narrower in front, the caudal rays and the posterior rays of the dorsal and anal fins being scaly to the very tip, but the anterior rays of the last two fins, as well as the pectoral and ventral rays, only half-way up, or only at the base, or even, in front, entirely naked. The same rule applies to the blind side, but here the scales disappear still more rapidly, the pectoral and ventral fins of this side being naked.

The lateral line proper runs upwards from the temporal region (the posttemporal bone), but soon takes a slightly curved, horizontal direction for a distance about equal to the postorbital length of the head, and then bends down rather suddenly to the middle of the side, running straight back from this point along the middle of the side out over the caudal fin. In the course of the lateral line the Whiff is thus most like the Brill, though the bend is still more elongated, with more marked steps. The change which is caused by growth in the pectoral fins, and which we have mentioned above, here gives rise to the character by which Couch proposed to distinguish between *Lepidorhombus megastoma* — somewhat younger, with relatively longer pectoral fins, the tip of the pectoral fin of the eye side extending to the end of the curved part of the lateral line — and *L. velivolans* — the largest specimens, in which the length of the pectoral fin, even on the eye side of the body, is less than that of the curved part of the lateral line.

The internal organs are like those of *Bothus;* but the stomach is still more saccate, and at the end of the pyloric part, which rises along the front side of its bottom, are attached two middle-sized appendages, curved in a downward direction.

Malm, who had seen fresh specimens of the Whiff, describes the coloration as follows: "The left side of the body is throughout of a light reddish, clayey gray[a], with 9 blackish shadings on the dorsal fin and 6 on the anal, the posterior ones being darkest. The caudal fin has two similar markings at the end of its first third, and three, one above another, at the middle of its length, these two series forming as it were transverse bands. Here and there on the body, especially behind the middle, we find blackish collections of streaks, these being caused by the brownish black colour of the hind margins of the scales at these spots. The pectoral fin is of the same colour as the body, with the exception of the last ray, which is white and opalescent. The eyes are yellowish brown above, yellowish white below. The pupil is bluish black. The iris is marked with a small, lemon-coloured ring next the pupil. At the top the iris forms a broad, rounded lobe, which encroaches upon the pupil, and is twice as large in the right eye as in the left. The right side of the body is entirely white."

The true habitat of the Whiff seems to lie round the coasts of Great Britain and Ireland and further south; it is said to be rare in the Mediterranean. Still, it is of frequent occurrence on the Norwegian coast up to Trondhjem Fjord, and has once, on the 20th of April, 1868, been found within the Skaw (Malm). It has long been known: even Jago sent to Ray[b] an easily recognisable figure of *a Whiff*, and Duhamel[c] figured it under the name of *limandelle ou grande calimande.* Owing to the thinness of its body, however, it has never excited the fisherman's interest, and we thus know but little of its manner of life. It is also strictly a deep-sea fish, as indicated by the large eyes. One of the specimens in the Royal Museum was taken N.N.W. of Bergen, at a depth of between 100 and 200 fathoms. Like many other fishes of this nature, however, it is occasionally borne to the surface in a helpless condition. Its appearance on these occasions has given it the name of *Sail Fluke*, conferred upon it by the fishermen of the Orkneys, who believe that in winter the Whiff ascends in calm weather to the surface, and by elevating the caudal fin turns it into a kind of sail. Frequently, however, it drifts ashore, and then hastens to hide itself in the sand, unless some keen-eyed gull seizes it at once, tears out the liver, which seems to be a delicacy, and then bears off the fish to some lonely cliff to be eaten at leisure[d]. It is said to be most common on the coasts of Devonshire and Cornwall, where it ascends so near shore on a sandy bottom that it is taken both in the trawl and with hook and line. The specimen obtained from the Skaw by Malm was taken in a seine, at a depth of 6 or 7 fathoms. On the coasts of France, according to MOREAU, it is rare, though it is sometimes exposed for sale. v. DÜBEN and KOREN assume that the spawning-season occurs in the spring, as on the 4th of April they took a female "with well-developed ovaries, though the roe did not seem quite ripe for depositing." On the Irish coast, on the other hand, THOMPSON found on the 21st of October a female that had just finished spawning, a few ripe eggs being still left in the ovaries. The Whiff is a voracious fish-of-prey, as is shown by its large gape, and lives on other fishes and crustaceans. As food it is of very little importance in Scandinavia, thin as it is and of so rare occurrence; but its flesh, according to DUGUID[a], is of exquisite flavour, though it will not keep a single day.

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[a] v. Düben and Koren write, "light yellowish brown, with a slight violet lustre."

[b] *Synopsis Piscium*, fig. 2.

[c] *Traité des Pêches*, part. 2 (tom. III), sect. IX, tab. VI, fig. 6.

[d] Richardson and Couch, ll. cc.

GENUS **SCOPHTHALMUS.**

Jaw-teeth of uniform size (no canines), pointed, recurved, small, and set in a card on the front part of the intermaxillary bones and of the lower jaw. Head of the vomer toothless or[b] *furnished with small, indistinct teeth. Palatine bones and tongue smooth. Lower pharyngeal teeth set in several rows (cardiform). Most of the fin-rays (except in the pectoral fin of the eye side) branched. Branchiostegal membranes united below for a little way and behind this point (also for a narrow strip) crossing each other. Branchiostegal rays 7. Median wall of the branchial cavity pierced above the urohyoid bone by an oval hole. Ventral fins free from the anal fin. Scales ciliated on both sides of the body. Anal spine and preanal spines wanting. Distance between the anal fin and the tip of the snout less than the length of the head.*

In 1810[c] RAFINESQUE coined a generic name, *Scophthalmus*, but this was probably merely a synonym of *Bothus*[d], which just precedes it in his work. BONAPARTE adopted this name[e], however, for a group of Bothoids (in his writings the genus *Rhombus*) which he characterized by the deep cleft of the mouth, the close approximation of the eyes, the situation of the vent exactly at the ventral edge, and the ciliated scales. The last character, which applies to both sides of the body, unites *Scophthalmus unimaculatus* of the Mediterranean and the Atlantic up to the Shetland Islands with *Scophthalmus norvegicus* of the Scandinavian fauna. Both these species too — as far as I could find in 8 specimens of *Scophthalmus norvegicus* — are without teeth on the palate. It is thus evident that they must belong to the same genus for which GÜNTHER has more recently[f] proposed the name of *Phrynorhombus*.

The genus *Scophthalmus* thus contains two species from European waters, the southern form with its deeper body, forming a sort of transition to the following genus, while the Scandinavian species is more akin to the preceding genus.

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[a] See RICHARDSON, l. c.

[b] In the Scandinavian species, according to STEENSTRUP.

[c] *Ind. Ittol. Sic.*, p. 53.

[d] See JORDAN and GILBERT, Proc. U. S. Nat. Mus. 1882, p. 576.

[e] *Icon. Fn. Ital.*, tom. III (Pesci), p. No. 23 (sub *Rhombus rhomboides*) and tab. 103 (sub *Rhombus unimaculatus*). Here, it is true, he speaks of *Scophthalmus* merely as a subgenus; but in the index (Nomenclatura moderna) he has included *Scophthalmus unimaculatus*.

[f] *Cat. Brit. Mus., Fish.*, Vol. IV, p. 414.

EKSTRÖM'S TOPKNOT (SW. SMÅHVARFVEN).

SCOPHTHALMUS NORVEGICUS.

Plate XIX, fig. 1.

Greatest depth of the body less than 40 %, total length of the head less than 25 %, length of the head behind the lower eye less than 14 %, maxillary bone of the eye side less than 10 %, maxillary bone of the blind side less than 9 %, branches of the lower jaw less than 12 %, pectoral fin of the blind side more than 8 %, base of the dorsal fin (measured in a straight line) less than 75 %, its greatest height (longest ray — 56th—59th) less than 11 %, base of the anal fin less than 65 %, its greatest height (about the 43rd or 44th ray) less than 11 %, the distance between it and the tip of the snout less than 23 %, length of the middle rays of the caudal fin more than $14^1/_2$ %, greatest thickness of the body more than 7 % — in each case relatively to the length of the body. Length of the pectoral fin of the blind side more than $^4/_5$ of that of the lower jaw on the same side, and the length of the middle caudal rays more than $^1/_3$ greater than that of the lower jaw and also more than $^1/_2$ the length of the head. Least depth of the tail more than 17 % of the greatest depth of the body.

R. br. 7; *D.* 74—83; *A.* 63—68; *P.* sin. 10, dextr. 7 l. 8; *V.* 6; *C.* 2+12+2 l. 3+10+3; *Lin. lat.* 50 l. 51.

Syn. *Pleuronectes Cardina*, FR., Vet.-Akad. Handl. 1838, p. 184 (excl. synon.) nec CUV.; SUNDEV., *Skand. Fisk.*, ed. I, p. 200, tab. 50; NILSS. (*Rhombus*), *Skand. Fn.*, *Fisk.*, p. 643.
Rhombus norvegicus, GTHR, *Cat. Brit. Mus.*, *Fish.*, vol. IV, p. 412; COLL. (*Zeugopterus*), Forh. Vid. Selsk. Christ. 1874, Tillægsh., p. 139; ibid. (*Lepidorhombus*) 1879, No. 1, p. 77; N. Mag. Naturv. Christ., Bd. 29 (1884), p. 100; MALM (*Rhombus*), *Gbgs*, *Boh. Fn.*, p. 518; LILLJ. (*Zeugopterus*), *Sv.*, *Norg. Fiskar*, II, p. 336.
Ekström's Topknot, COUCH, *Fish. Brit. Isl.*, vol. III, p. 175, tab. CLXVII.

Obs. CUVIER'S *Pleuronectes* (*Rhombus*) *Cardina* is clearly a combination of *Scophthalmus*, to which he refers in his quotation of DUHAMEL (*Tr. Pêches*, sect. IX, pl. VI, fig. 5), and *Lepidorhombus whiff*, as shown by his quotation of RAY (*Syn. Pisc.*, p. 163, pl. 1, No. 2). FRIES, too, regarded *Scophthalmus norvegicus* as identical with *Sc. unimaculatus* (Bloch's Topknot).

Ekström's Topknot fully deserves the Swedish name (= Small Fluke) given it by FRIES and SUNDEVALL. Its maximum length is apparently about 12 cm. The largest specimen ever found in Scandinavia was 117 mm. long. Thus, to the best of our knowledge at present, it is the smallest Scandinavian Flatfish. The body is of a regular oblong shape, elliptical but elongated and narrow at the head and tail. The greatest depth, which increases even relatively with age, varies between $31^1/_2$ and $37^1/_2$ % of the total length of the body, or between 37 and 45 % of the length of the body *minus* the caudal fin. The snout forms a slightly rounded angle of somewhat less than 90°. At the upper eye there is a slight depression in the profile of the head (see the preceding species), but the lower jaw, with its feebly marked chin, projects beyond the ellipse in a rectilinear, obtuse angle. Behind the terminations of the dorsal and anal fins the tail forms a section of uniform depth, measuring about $^1/_5$ (18—23 %) of the greatest depth of the body, and almost as long as it is deep, this being one of the most prominent distinctions between this species and the Whiff.

The length of the head is between $23^1/_2$ and $22^1/_2$ % of the total length of the body, or between $28^1/_2$ and $26^1/_2$ % of the length of the body to the base of the caudal fin. Its external form we have just described. The eyes are set close together on the left side. They are oblong and very prominent, the upper being somewhat larger than the lower, and situated a little behind it, close to the depression in the upper profile of the head. The lower eye is set close to the margin of the jaw. The iris and pupil are simple, of normal shape, and without any intruding lobe from the former into the latter. The narrow and terete interorbital space (the projecting ridge between the eyes) forms a carina, which follows the curve of the margin of the lower eye from the middle of the side of the upper jaw, and then coasts the margin of the upper eye, vanishing behind this point. The nostrils resemble those of the rest of the Bothoids: the openings are small, a little way apart, with high, soft margin, which in the anterior nostril is tubular and obliquely truncate, and behind elongated into a flap that may be depressed, and close the opening like a lid. On the eye side they are set just in front of the interorbital carina, and on the blind side in a straight line with the beginning of the dorsal fin. The mouth is large. The lower jaw ascends at an angle of rather more than forty-five degrees, and projects only slightly in front of the upper. The upper maxillary bone, which broadens slightly behind, extends below the anterior margin of the pupil of the lower eye, the margin of the jaw being formed by the intermaxillary bone alone, which, like the lower jaw, is clothed with a tumid, labial skin. The jaw-teeth are numerous, fine, sharp, somewhat curved, and cardiform; in front they are set in several rows, laterally almost in a simple row, and they are finer on the eye side than on the blind side. The pharyngeal teeth resemble the jaw-teeth. The lower pharyngeals are armed with a fairly broad patch of teeth, of an elongated crescent-shape and containing several rows. The palatal fold of the upper jaw is fairly large. The intermaxillary bones are fairly mobile. The branchiostegal membrane is furnished on each side with 6 rather long, somewhat compressed rays and one smaller ray, the latter set near the median line. As in all the other Bothoids no part of the margin of the opercular apparatus extends to the lower edge of the body, but this margin curves upwards, forming an angle with the lower jaw. The gill-opening is large, extending from this angle some way above the base of the pectoral fin, where the operculum and suboperculum form a blunt, projecting, free point.

The lateral line starts from the temporal region, on about a level with the middle of the upper eye, in a slightly upward direction, but soon forms a regular arch, extending over 12—14 scales, above the pectoral fin, then an angle somewhat above the middle of the body, and finally advances in a straight line to the middle of the caudal fin. This straight part of the lateral line is covered by 38 or 39 scales, which are more obtuse in shape than the others, and are each furnished with a muciferous canal. In an oblique row backwards, we find about 20—22 scales between the angle and the anal fin, and 15 or 16 between it and the dorsal fin. The scales are thus comparatively large, though smaller than in *Platophrys* (*Arnoglossus*) *laterna*, in which the scales are relatively larger than in any of the Scandinavian Flatfishes. At the middle of the body, above the lateral line, in a specimen 117 mm. long, the scales are 2 mm. broad (high) and somewhat longer than broad, hexagonal, with regular, straight sides and almost rectilinear angles, the base alone (the inserted, anterior margin) being as usual sinuous and irregular. The hindmost angle is rather more acute than the others. As this angle is included by two straight lines equal to each other, the visible part of the scale forms a regular rhombus, which takes its colour from the highly adhesive epidermis. The free (hind) margin is bent somewhat, though only slightly, outward, and with about 30 (somewhat fewer on the blind side), small, fine, straight spines, which are almost recumbent but not depressed. In these scales, as is generally the case with ctenoid scales, the nucleus lies near or at the tip. From this point the radiating lines diverge to the whole extent of the base, and the concentric lines are not concentric with the hind margin, but end therein parallel to each other. The scales cover the whole body and head, except the mouth, and all the fin-rays.

The dorsal fin begins near the dorsal margin, on the blind side. The first 4—6 rays are equal in length and nearly half free, but there is no very prominent ray. From this point the rays gradually increase in length, the 55th—60th being longest, rather more than half as long again as the first ray, and measuring 10 or 11 % of the length of the body. The remaining rays decrease in length, and the last four or three are rather short, but, as in the species next to be described, form a small, rounded lobe, which is inserted distinctly on the blind side, though not so depressed as in the next species. All the rays are free to some extent at the tip, and branched, but this is not distinct in front until the middle of the fin is reached. The last, small rays are deeply branched, the last of all down to the base. The anal fin begins vertically below the hind margin of the preoperculum. It is throughout analogous to the corresponding part of the dorsal fin, generally equal to it in height, and ends opposite the termination thereof, with a similar lobe on the blind side. The distance between the terminations of the dorsal and anal fins is about 73—83 % of the least depth of the tail. The pectoral fin of the eye side contains 10 rays, all perfectly simple, a characteristic which is peculiar to this species and *Drepanopsetta platessoides*. The first ray is small and lies still closer to the second than in the Whiff; the length of the second ray is $^2/_3$ of that of the fin. The fourth ray is the longest, its length in young specimens being only slightly less than that of the head. The last ray is about half as long as the fin. The total length of the fin in young specimens is as much as $^1/_7$ of the length of the body, in old about 13 % thereof. The pectoral fin of the blind side is considerably shorter, measuring somewhat more than $^1/_3$ (in young specimens $^3/_5$) of the length of the head, and more rounded, with the middle rays branched. The ventral fins, as in most of the Bothoids, are set under the head, just behind the lower jaw, look like the vertical fins, and apparently form an immediate, reduplicated continuation of the anal fin, though they are separated from the latter, not by any interval or by shorter rays, but only by the absence of the fin-membrane between their last rays and the first ray of the anal fin. Their relative length decreases with age, the base of the left ventral fin varying between about 8 and $6^2/_3$ %, that of the right ventral fin between about 7 and $5^1/_2$ %, of the length of the body. Their height is about 5 or 4 % of the length of the body. The right fin is thus rather smaller than the left; both are concave in the plane of the blind side. The caudal fin generally has two supporting rays on each side; the other rays are trebly bifid, and fairly equal in length, giving the fin a rounded shape when it is expanded.

The anal spine is wanting. The vent lies far forward, vertically under the opercula and between the ventral fins. The viscera are exactly like those of the preceding species, but the intestine is still shorter, and we have failed to discover any pyloric appendages. The largest two specimens we have examined, the type-specimens of Fries, are females, the one with extremely small eggs, the other with some of the eggs of a larger size, though the largest is only about $^1/_3$ mm. in diameter.

The coloration of the eye side is yellowish brown, with numerous, dark brown clouds along the dorsal edge and the ventral margin. A large, more distinct, almost band-shaped spot crosses the lateral line, through the angle, at the end of the first third of the body, and another, which is rather indistinct, at the end of the second third. All these spots are arranged in such a manner that they seem to be traces of 8 broad, transverse bands, namely, one indistinct band in front of the eyes, a second across a gill-cover, a third across the angle of the lateral line, three on the body behind this point, a seventh, fairly distinct and continuous, across the narrow part of the tail, between the end of the dorsal fin and that of the anal fin, and an eighth across the base of the caudal fin. The fin-rays are also spotted. The blind side is white throughout.

We are not in a position to give the sexual differences, as both the larger specimens we have seen were females, and the smaller ones of uncertain sex.

This species was first discovered and entered in the system by Fries, whose type-specimens are still preserved in the Royal Museum, and were taken in a dredge at the entrance of Gullmar Fjord near Fiskebäckskil, in the island-belt of Bohuslän, on the 6th of April, 1838. It was subsequently found off Bergen, according to Nilsson[a], in the winter of 1844 by v. Düben and Koren, who referred the specimens, however, to *Lepidorhombus whiff*. Couch described and figured a specimen that "was taken early in the year 1863, in the Bristol Channel." Collett found the species fairly common in Christiania Fjord. G. O. Sars met with it off Bodö and Stavanger, Storm in Trondhjem Fjord[b]. In recent years the Royal Museum has received three small specimens, between 40 and 65 mm. long, from the Zoological Station of Kristineberg — the locality from which Fries also obtained his specimens — and another, 74 mm. long, from the Weather Is. in Bohuslän. The geographical range of Ekström's Topknot thus extends at least from the Bristol Channel to the Lofoden Islands. It is probably not rare on the coasts of Scandinavia, though it has been found comparatively seldom, partly on account of its small size, and partly as it probably passes the greater part of its existence in water deeper than that usually fished with the seine. Fries obtained his specimens "in deep water," v. Düben and Koren took theirs at a depth of 15 or 20 fathoms. Collett, however, found one specimen in 6 fathoms of water. Nothing more is known of the habits of Ekström's Topknot.

(Sundevall, Smitt.)

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[a] *Skand. Fauna, Fiskarne*, p. 643, Note 2, and p. 645.

[b] "With a dredge small specimens may be taken pretty often on a rocky bottom, even in the innermost parts of the fjord:" Norsk. Vid. Selsk. Skr., Trondhj. 1883, p. 40.

GENUS ZEUGOPTERUS.

Jaw-teeth of uniform size (no canines), pointed, recurved, small, and set in a card on the front part of the intermaxillary bones and of the lower jaw. Head of the vomer also furnished with small teeth, but the palatine bones and tongue smooth. Lower pharyngeal teeth set in several rows (cardiform). Most of the fin-rays branched. Branchiostegal membranes partially united below, but further back meeting in different planes, the one crossing the other. Branchiostegal rays 7. Median wall of the branchial cavity pierced above the urohyoid bone by a hole. Ventral fins united by the fin-membrane to the first ray of the anal fin. Scales on the eye side of the body ciliated at the hind margin, on the blind side smooth-margined. Anal spine and preanal spines wanting. Distance between the anal fin and the tip of the snout less than the length of the head.

Only one species of this genus is known, the systematic significance of which in relation to the preceding genera we have already touched upon. The characters on which the genus is based, are, however, of only secondary rank. In a young specimen, 12½ mm. long, which the writer took in a hoop-net at the surface, at about the middle of the west entrance of the English Channel, where there were 55 fathoms of water, and in which specimen the right eye had only just begun its passage under the free, projecting front part of the dorsal fin, the ventral fins are separated from the anal fin by an interval equal in length to their own bases, and both the dorsal and the anal fins terminate posteriorly at the middle of the edges of the body. The independence of the genus has thus no more significance than that of a distinct stage — the most advanced of all — in the course of development that has started from an ancestral Bothoid type common to this genus and the preceding one.

The genus was established in 1835 by GOTTSCHE, but gained no further recognition until STEENSTRUP, who included in it the two preceding genera as well, thirty years after pointed out the characteristic breach in the wall between the two branchial cavities.

MÜLLER'S TOPKNOT (SW. LUDNA HVARFVEN[a] OR BERGHVARFVEN[b]).

ZEUGOPTERUS PUNCTATUS.

Plate XIX, fig. 2, and fig. 116.

Greatest depth of the body more than 46 %, total length of the head more than 26 %, length of the head behind the lower eye more than 14 %, maxillary bones of both sides more than 10 %, branches of the lower jaw more than 12 %, pectoral fin of the blind side more than 8 %, base of the dorsal fin (measured in a straight line) more than 84 %, its greatest depth (longest ray — about the 60th—70th) more than 11 %, base of the anal fin more than 73 %, its greatest height (longest ray — about the 40th—47th) more than 11 %, distance between the anal fin and the tip of the snout less than 23 %, length of the middle rays of the caudal fin less than 13 %, greatest thickness of the body more than 7 % — in each case relatively to the length of the body. Length of the pectoral fin of the blind side less than 77 %, but more than 66 %, of that of the lower jaw on the same side, and the length of the middle caudal rays less than either the length of the lower jaw or half the length of the head.

Least depth of the tail less than 16 % of the greatest depth of the body.

R. br. 7: *D.* 87—99[c]; *A.* 67—75[d]; *P.* sin. 11 l. 12, dextr. 10 l. 11 (12); *V.* 6; *C.* 2 + 12 + 2[e]; *Lin. lat.* ca 200; *Vert.* 36 l. 37.

Syn. *Pleuronectes punctatus*, BL., *Naturg. Ausl. Fische*, part. III, p. 31, tab. CLXXXIX; WALB., *Ichth. Art.*, part. III, p. 116; GTHR (*Rhombus*), *Cat. Brit. Mus., Fish.*, vol. IV, p. 413; COLL. (*Zeugopterus*), Forh. Vid. Selsk. Christ. 1874, Tillægsh., p. 139; MALM, *Gbgs, Boh. Fn.*, p. 518; WINTH., Naturh. Tidskr. Kbhvn, ser. 3, vol. XII, p. 38; DAY, *Fish. Gt. Brit., Irel.*, vol. II, p. 18, tab. C; COLL., N. Mag.

[a] NILSSON, l. c.

[b] MALM, l. c.

[c] Sometimes 101, according to DAY.

[d] Sometimes 80 or even 89, according to GOTTSCHE.

[e] Or 1 + 14 + 1, or 2 + 13 + 1.

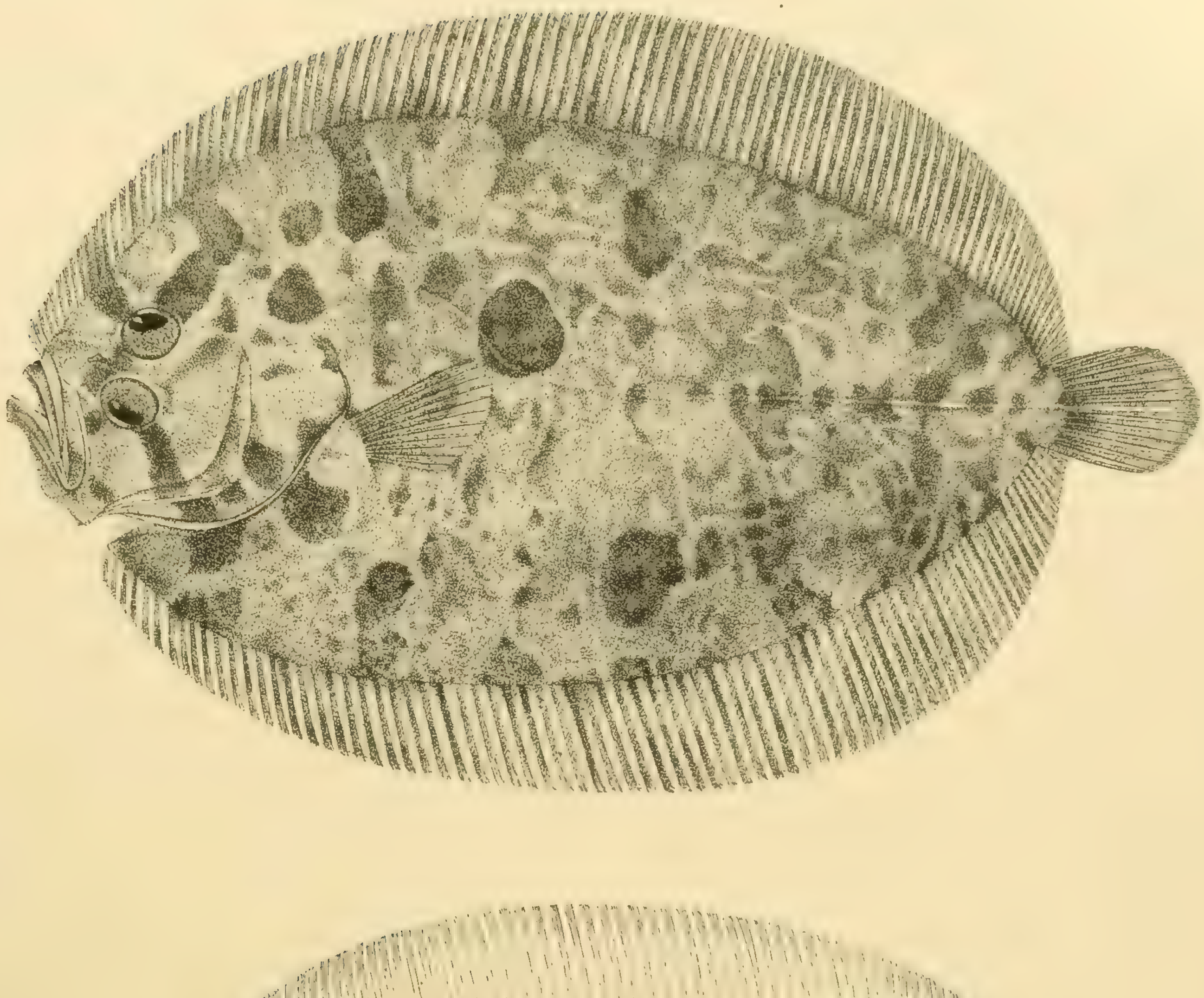

Fig. 116. *Zeugopterus punctatus*, natural size, from Bohuslän, 1837. Forwarded to the Royal Museum by Didrikson.

Naturv. Christ., Bd. 29 (1884), p. 101: Lillj., *Sv., Norg. Fn., Fisk.*, vol. 2, p. 350.

Pleuronectes hirtus. Abildg. apud Müll., *Zool. Dan.*, vol. III, p. 36, tab CIII; Retz., *Fn. Suec. Lin.*, p. 333; Nilss., *Prodr. Ichth. Scand.*, p. 59; Gottsche (*Zeugopterus*), Wiegm. Arch. Naturg., I. 2, (1835), p. 178; Fries (*Pleuronectes*), Vet.-Akad. Handl. 1838, p. 184; Yarr (*Rhombus*), *Brit. Fish.*, ed. 1, vol. II, p. 243; Parn., Mem. Wern. Soc., vol. VII, p. 376; Kr., *Danm. Fiske*, vol. 2, p. 445; Nilss., *Skand. Fn., Fisk.*, p. 646; Mor., *Hist. Nat. Poiss. Fr.*, tom. III, p. 321.

Muller's Topknot, Couch, *Fish. Brit. Isl.*, vol. III, p. 170, tab. CLXV.

Müller's Topknot attains a length of about 25 cm. The body is elliptical and of more uniform depth than in the preceding genus, the greatest depth of the body remaining almost unchanged for some distance, about half-way between the tip of the snout and the caudal fin. The depth at this spot varies, at least after the fish has attained a length of 90 mm., between 46 and 51 % of the total length of the body, the proportion rising fairly regularly with age. In front the body is almost semicircular, behind more elongated, the least depth (across the peduncle of the tail) varying between $6^{1}/_{2}$ and 8 % of the total length of the body, and also increasing, even relatively, with age. The form of the body is most affected, however, by the dorsal and anal fins, which increase in height posteriorly, while the depth of the body itself diminishes. When these fins are taken into account, the body is deepest at about the beginning of the fourth quarter of the distance between the tip of the snout and the base of the caudal fin. This depth is about 66 or 68 % of the total length of the body. The greatest thickness of the body in old specimens is distinctly greater than in the preceding genus, increasing with age from about 8 to 9 % of the length of the body.

The most remarkable point in the form of the head is the sharp ascension of the cleft of the mouth. When the mouth is closed, the jaw-bones, at least the maxillaries, assume an almost perpendicular position; but the mouth is also highly protrusile, much more so than in the preceding genus. The intermaxillary bones may be shot forward for a distance equal to the length of the snout proper; the lower jaw is then horizontal, the branches of the intermaxillary bones place themselves at right angles to it, and the lower end of the maxillary bones is directed obliquely forward. The jaw-bones are fairly symmetrical, those of the eye side being only slightly longer than those of the blind side, or equal to them in length. Just as the head as a whole is comparatively larger than in the preceding species — its length undergoes even relative increase, during the growth of the fish, from $26^{1}/_{2}$ % to rather more than 28 % of the length of the body — the jaws are also even relatively longer than in Ekström's Topknot. The length of the branch of the lower jaw on the blind side increases with age from about 12 to nearly 14 %, that on the eye side from 13 to a little more than 14 %, of the length of the body; and the corresponding alterations in the maxillary bones are from about $10^{1}/_{2}$ to $12^{1}/_{2}$ % (sometimes nearly 13 %) of the length of the body. The length of the lower jaw, however, is always less than that of the head behind the lower eye, which increases with age from about $14^{1}/_{2}$ to $16^{1}/_{2}$ % of the length of the body. The eyes are fairly large, their longitudinal diameter relatively decreasing during growth, from about $38^{1}/_{2}$ to $25^{1}/_{2}$ % of the postorbital length of the head; but they are comparatively smaller than in either of the two preceding genera. Their position in relation to each other continues to change at a late period in the growth of the fish: when the fish is 17 cm. long, we may find the eyes still almost abreast of each other, while in specimens 2 dm. long the wandering (originally the right) eye may have retired half its diameter behind the lower eye. There is no intruding lobe from the iris into the pupil; but the rough skin that covers the inner (in the lower eye the upper, in the upper eye the lower) part of the eye, projects in a more or less arcuate form out over the pupil. The interorbital space is not remarkably broad in comparison with its breadth in other *Bothinæ*, but it is broader than in the two preceding genera, its least breadth varying in this species between 30 and 45 % of the longitudinal diameter of the eye. It is only on the eye side that the nostrils are always distinct, or at least the anterior, with its foliate dermal flap. On this side they are set close to each other, on about a level with the middle of the interorbital ridge, and the posterior just in front of the perpendicular from the anterior margin of the lower eye. On the blind side they are extremely small — where they are present at all — as fine as the pores of the lateral line, and in most of our specimens they are impossible to detect in the loose skin that covers the nasal cavity, just behind the articulation of the maxillary bone, below the second and third rays of the dorsal fin. In one of our specimens they are present in the form of open, but extremely small holes, in another they are somewhat larger, but covered by skin. The operculum and suboperculum resemble those of the preceding species; but the interoperculum is still more tapering in front than in Ekström's Topknot, with a distinct sinus in the lower margin, and also more distant from the lower jaw, to the angular part of which it is united by ligaments and rough skin. The preoperculum is obtuse-angled, with a sinus in the hind margin just above the angle. The jaw-teeth in front form a dense and fine card. The palatal folds are well-developed, but in the upper jaw no broader than the card of teeth, in the lower jaw still narrower. The gill-rakers are set in a single row on the first branchial arch, as in most of the *Bothinæ*, but are rather numerous, about 23 on this arch. The lower pharyngeals are distinctly narrower than in Ekström's Topknot and without any marked expansion for the patch of teeth: they are furnished with only four or five rows of teeth, pointed like the jaw-teeth but straight.

The margin of the body is entirely surrounded with fins, with the exception of the small sections occupied by the lower jaw, the intermaxillary bones, and the extremely short peduncle of the tail. The dorsal fin begins so far forward that its commencement, which forms a lobe on the blind side, covers even the upper end of the maxillary bone; while the ventral fins, which are united to the anal fin, begin just behind the lower jaw. Both the dorsal and the anal fins cross over behind to the blind side, where their last rays form lobes which converge so sharply that the distance between the bases of the fins at this end is less than $^2/_3$ (sometimes less than $^1/_2$) of the least depth of the tail. On the blind side these posterior rays extend beyond the base of the caudal fin; but on the eye side this arrangement produces a small, finless peduncle, the length of which is no more than about $^1/_4$ of its depth. All the rays of the dorsal and anal fins are branched; but the ramification grows more pronounced posteriorly, the longest rays being most repeatedly branched, the last rays most deeply, the hindmost four or five right down to the base. The caudal fin is comparatively short, and sharply rounded at the hind margin. Both the ventral fins are united by a perfect fin-membrane to the first ray of the anal fin, and thus form an elongated, or rather, channel-like cup, open in front. In the hind part of the bottom of this cup, just in front of the anal fin and almost at the middle of the ventral margin, we find the anal and genital openings, while the urethral papilla, as in most of these forms, lies on the eye side, beside the first ray of the anal fin. All the rays of the ventral fins are branched, the last rays most deeply, and even more than the first ray of the anal fin. The difference in size between the two ventral fins is inconsiderable, that of the blind side being inserted only slightly, if at all, behind that of the eye side. The length of their base as well as their height varies between about 6 % (on the blind side sometimes $5^1/_2$ %) and 7 % of the length of the body. The pectoral fin of the eye side is obliquely rounded, the fourth ray being the longest, but only slightly longer than the third. The two highest and the two lowest rays — sometimes only one on each side — are simple, the first ray very small, generally only $^1/_3$ of the second, and closely united to the latter, and the eight middle rays are branched. The pectoral fin of the blind side is of almost the same shape and structure, the only differences being that the fifth and sixth rays are the longest and generally equal in length, and that the rays are usually fewer, to which we may add that though the fin as a whole is shorter than the pectoral fin of the eye side, the first ray is as long as in the latter fin. The length of the pectoral fin of the eye side varies between about 13 and 14 % of the length of the body, of the blind side between about $8^1/_2$ and $10^1/_2$ % thereof.

The Swedish name of Müller's Topknot (*luddhvarf* = Hairy Fluke) is based on the name given the species by ABILDGAARD (*Pleuronectes hirtus*), and is derived from the singular structure of the scales. It is scarcely possible for a fish to be more thoroughly covered with scales than Müller's Topknot is on the eye side. The whole body and head, the jaws and even the intermaxillary bones, as far as they are exposed when the mouth is shut, and all the fin-rays are clothed on this side of the body with small but firmly attached, ctenoid scales. These scales are thin, in form semi-elliptical, with numerous, undulating grooves radiating towards the round, inserted end, and fine, circular striæ eccentrically arranged round the nucleus, which lies close to the truncate, posterior end. Only a narrow strip of the truncate part is left bare by the scale immediately in front, and this strip bears at the margin a transverse row of denticles, generally 8 or 9 (together with an inconstant number of extremely small ones). The denticles are set at right angles to the plane of the scale, conical, and pointed, and here and there on the body one of the middle ones is developed into a spine visible even to the naked eye. The surface of the eye side of the body is, therefore, rough in whatever direction the hand is passed over it, though roughest when stroked from behind, and feels like hard velvet. The blind side of the body, on the other hand, is smooth, the scales being cycloid, somewhat more elongated, and overlapping each other only to the usual extent. On this side, too, the scales are wanting on the head and all the fin-rays, except in the caudal fin. The lateral line of the body, which begins in the temporal region, on a level with the middle of the posterior eye or somewhat higher — here, as in the other Flukes, considerably above the upper angle of the gill-openings — forms a rather low and elongated, sinuous curve over the pectoral fin, until, just behind the tip of the left pectoral fin and somewhat above the middle of the sides, it resumes its straight course back to the middle of the caudal fin.

The intestinal canal reminds us in its course of the Soles. The œsophagus with its continuation, the stomach, runs almost straight along the roof of the abdominal cavity into the left secondary cavity, somewhat beyond the middle of the length of the body, where the stomach ends in the form of a blind sac. From the lower side, just in front of its bottom, it sends out a short pyloric part, externally separated by contractions both from the stomach and the small intestine, which latter runs forward in a curve convex from below to the front wall of the abdominal cavity, where it bends sharply upwards to return in a circular coil on the right side of the liver to the rectum, which leads to the vent. The liver, which lies as usual to the left, is comparatively small, and the pyloric appendages are wanting. The left ovary extends when ripe back to the beginning of the last quarter of the body, while the right ovary at the same period extends only a little beyond the middle of the body.

The coloration of the eye side, though extremely variable, renders Müller's Topknot one of the most handsome of the Scandinavian Flatfishes. v. Wright's figure (Pl. XIX, fig. 2) represents a young specimen 27 mm. long. This specimen is of a violet-gray ground-colour, with an ash-gray lustre, strongest on the jaws and the caudal fin, and brown and pale yellow spots and streaks. The most prominent marking on the body is a sharply defined, brownish black spot, as large as one of the eyes, situated just in front of the middle of the body, at the end of the curve of the lateral line. Next come the brown spots on the gill-covers; two of these are especially distinct, in the form of oblique stripes, one running upwards in an oblique posterior direction from the upper eye, and one downwards in an oblique posterior direction from the lower eye. Even in front of the eyes we find traces of a transverse stripe. Along the bases of the dorsal and anal fins runs a row of alternate, brown and pale yellow spots, the former, in accordance with Sundevall's explanation of the colouring of the preceding species, being traces of transverse bands across the body and fins, the latter a common marking of the Flatfishes, especially the fry. Similar pale yellow spots also occur on the gill-covers, and indistinct, scattered ones on the body. In old specimens the ground-colour is yellowish brown, with numerous, brown or nearly black, transverse spots or bands on the body and fins. Three of these bands generally start from the anterior part of the superior margin of the upper eye, diverging out over the dorsal fin. A fourth, broader band runs from the hind margin of this eye obliquely upwards to the dorsal fin, and in most cases may be traced between the eyes, and is continued downwards, obliquely backwards across the cheek and interoperculum, out over the first rays of the anal fin. From the anterior part of the lower eye we may generally find traces of divergent brown bands, one forward along the snout, another downward, across the middle of the lower jaw, and a third obliquely backward, over the left ventral fin. On the body itself the brown bands are usually broken up more thoroughly into oblong or round spots; but on the operculum and suboperculum the arrangement of these spots still shows traces of a band, running parallel to the interrupted angular band of the eye, and this arrangement may sometimes be traced all the way along the body. About 15 or 16 transverse bands seem to have crossed the dorsal fin, and about 12 the anal. The most prominent of the spots are the round one which we have mentioned above, at the end of the curve of the lateral line, another, which is not so distinct, further back along this line, and a third on the upper part of the operculum. The blind side is white.

Müller's Topknot occurs at least from the neighbourhood of Trondhjem south to the Bay of Biscay on the south-west of France; but in the extreme north as well as in the extreme south of its range it is rare, or at all events of infrequent occurrence, so that it is strictly a British fish. It does not enter the Baltic, but is taken pretty often on the coast of Bohuslän and in the comparatively deep channel along the west coast of Sweden, as well as in the east of the Sound, down to the neighbourhood of Landskrona. According to SCHAGERSTRÖM[a], however, its usual length in the Sound is no more than 12—15 cm., though a specimen 22 cm. long has been taken off Landskrona. According to MALM it is found "along the whole coast of Bohuslän, where it generally keeps to a rocky bottom, at a depth of from 7 to 9 fathoms, and is taken pretty often, partly in Flounder-nets and partly in lobster-pots." FRIES found the species in 1836 and 1837 at the entrance of Gullmar Fjord; and in recent years the Royal Museum has received specimens of Müller's Topknot that had been taken together with other fishes in the Cattegat, "12 miles off Halmstad."

The food of Müller's Topknot is composed of fish and crustaceans. In the pharynx of a specimen 20 cm. long, from Dynekil, I found a Black Goby, of a total length of about $8^1/_2$ cm., but with the forepart already digested, while the hind part and the caudal fin had stuck fast in the pharynx. In the stomach of Müller's Topknot GOTTSCHE found shrimps (*Palæmon* and *Mysis*), KROYER "a half digested fish, perhaps a young Herring," and OLSSON[b] Sand-eels (*Ammodytes*).

The spawning-season occurs in spring and summer. The above specimen from Dynekil is a female with almost ripe roe, and was taken on the 12th of May, 1887; and on the 11th of June, 1853, MALM received a female that had been taken off Inholmar[c], and "was on the very point of depositing its roe." In September the fry have attained a length of about 25 mm. "As the ovaries are by no means small, and the eggs extremely fine and consequently very numerous, it is difficult to explain," says KROYER, "why this species is so rare in our waters."

Still, Müller's Topknot is not a rare species, but it is despised. Fishermen generally pay no attention to it: its handsome appearance has no charms for them. In Scandinavia there is no demand for it, though its flesh[d] is said to be of excellent flavour.

ONOMORPHI.

Symmetrical Malacopterygian Physoclysts[e] with the lower pharyngeals free from each other. Caudal fin diphycercal (isocercal). Ventral fins, where present, jugular.

The Codfishes, the type of this series, were known by the Greeks as *onos*[f], by the Romans as *asellus*, both these names referring to the coloration of the body in these fishes, gray above and white below, which apparently had some fancied resemblance to the colour of the ass. The series is particularly rich in forms, and includes the greater part of MÜLLER's *Anacanthini*[g]. In GÜNTHER's writings it is termed *Anacanthini gadoidei.*

From the rest of the Malacopterygian Physoclysts the series is sufficiently distinguished by its symmetrical structure, which is not disturbed, as in the preceding series by any shifting of the eye, and by the free lower pharyngeals, which are not united to each other, as in the next preceding series. In addition to these characters, however, it has one which separates it from most of the preceding osseous fishes in general, and which lies in the structure of the caudal fin. In the Onomorphous fishes this part of the body apparently remains persistently at a stage of development that is proper to the embryo in most fishes, the termination of the spinal column being straight at the end, and occupying the middle of the base of the caudal fin. In most of the Onomorphs the caudal part retains this structure throughout the life of the fish; or the caudal fin may even be absolutely reduced, in which case the tail ends like a whip-lash. But in the true Cods and their kindred species, with well-developed (secondary) caudal fin, the last two hæmal arches are transformed into true hypural bones — not so high, however, as those of the homocercal fishes proper — to support the middle rays of the caudal fin or even the greater part of these rays. In these fishes the caudal end of the spinal column is also bent upwards, at least to such an extent that it lies, in the ordinary urostyloid form, more or less closely along the upper margin of the hindmost (uppermost) hypural bone (fig. 117). The diphycercal appearance of the fin is also increased by the marked development of the numerous supporting rays, which are of similar form above and below. The character drawn from the diphycercal caudal fin is thus not absolutely valid, but is not entirely destitute of significance, especially in comparison with the preceding series, where the hypural bones are extraordinarily well-developed, and the caudal end of the notochord is bent sharply upwards for so long a distance that the original caudal end of the body, with its embryonic (diphycercal) caudal fin (fig. 98, *e* and fig. 99, *a*, pp. 362 and 363, above), even in young Flatfishes 8—12 mm. in length, still projects above the true caudal fin, and reminds us how this fin has developed from the strictly heterocercal caudal fin[a].

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[a] Physiogr. Sällsk Tidskr., p. 312.

[b] Lunds Univ. Årsskr. 1871, p. 10 (sep.).

[c] North of Vinga, in the island-belt of Gothenburg.

[d] CORNISH, in DAY.

[e] According to GÜNTHER (*Report On the Shore Fishes*, Zool. Chall. Exp., Part. VI, p. 18) *Maraenolepis* — fam. *Ophidiidæ*, but with the first ray of the dorsal fin filamentous and separated from the others — is furnished with a pneumatic duct from the air-bladder. Thus, this genus, within the above family, has the characters of the Eels (*Apodes*) as well as of the Onion-fishes (*Macruridæ*).

[f] ὄνος or ὀνίσκος; also καλλαρίας or γαλλαρίας. The largest Cods, however, according to PLINY (lib. 9, cap. 17), were known by the Greeks as *bacchus*. *Gadus* is a younger Greek name, which is said to occur first in ATHENÆUS (about 150 A. D.), in a quotation from DORION: "Ὄνος ὃν καλέουσί τινες γάδον."

[g] COPE (Trans. Amer. Philos. Soc., Philad., vol. XIV, n. ser., p. 458) and GILL (Smiths. Misc. Coll., No. 247, p. 3) also confine the name of *Anacanthini* to this series exclusively.

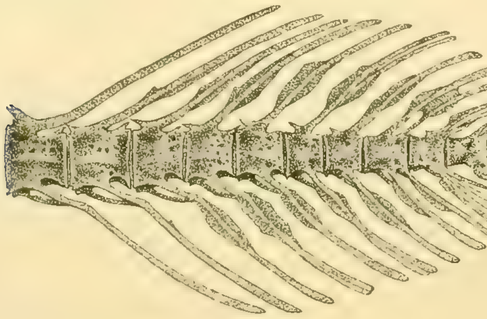

Fig. 117. Hind termination of the spinal column in a Cod (*Gadus callarias*). 1½ times of the natural size.

This primitive, imperfectly specialized type of the form of the caudal fin in the Onomorphous fishes is frequently accompanied by a no less imperfect specialization in the structure of the other unpaired fins. Here, as in several of the Blennomorphs and Gobiomorphs, we find these fins, especially in the deep-sea forms — which also show several other embryonic characters[b] — continuous (united to the caudal fin) or separate. The specialization is so far advanced, however, that in the most typical Onomorphs the dorsal and anal fins are more variable in form and number than is generally the case in the other series.

The jugular position of the ventral fins indicates an advanced specialization, just as, in the preceding part of this work, we have repeatedly seen the progressive development of the osseous fishes accompanied by the removal in a forward direction of these fins. In this respect too, the development sometimes advances so far that it leads to degeneration, for the ventral fins disappear in several forms, especially among deep-sea fishes.

Another degeneration, which shows how the Onomorphous type has succeeded in adapting itself to the most unfavourable environments, is the reduction of the organs of sight which occurs in those fresh-water fishes of the genus *Lucifuga* that inhabit the subterranean caves and rivers of Cuba, and in *Aphyonus*, which dwells in the abyssal zone, in from 900 to 1,400 fathoms of water, and which very closely resembles *Lucifuga* in the form of the body as well as in this degeneration[c]. Equally singular are the conditions of life to which the genera *Fierasfer* and *Encheliophis* have bound themselves, a commensalism, in which they inhabit *Medusæ*, *Holothuriæ*, or shellfish. In these last forms the degeneration may involve not only the loss of the ventral fins, but also of the pectoral, the vent assuming a jugular position.

During all these varying conditions of life, from salt water to fresh, from the surface to the abyssal depths of the ocean, from independent existence to a sort of parasitism, the type of the series has undergone so manifold modifications, and the degenerations specified above have exercised so many disturbing influences on the regular course of development, that the characters of the families are in many respects inconstant and melt into each other. The validity of the following division is, therefore, only general, though without exception in the Scandinavian fauna.

A: Caudal fin more or less distinctly independent of and separated from the dorsal and anal fins. Hind part of the body more or less terete.
  a: Jaws furnished with teeth .... Fam. *Gadidæ.*
  b: Jaws toothless .... Fam. *Ammodytidæ.*
B: Caudal fin not distinct, but, where present, united either to the dorsal fin, or to the anal fin, or to both. Hind part of the body Anguilliform or compressed, like a whip-lash.

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[a] Cf. A. Agassiz, Proc. Amer. Acad. A., Sc., n. ser., vol. V, p. 117 etc. (Boston, 1877).

[b] One of the remarkable instances of this we find in *Aphyonus* (Gthr, *Rep. Deep-Sea Fish.*, Chall. Exp., part. LVII, p. 120, pl. XXVI, fig. A), in which the embryonic notochord is persistent, showing merely external traces of vertebral segmentation.

[c] Günther, *Introduction to the Study of Fishes*, pp. 547 and 548; *Handb. Ichth.*, pp. 390 and 391.

a: Gill-openings large; branchiostegal membranes united to each other to a greater or less extent and free from the isthmus.
  α: Anterior part of the dorsal fin-system separated into a distinct fin, or at least with the anterior rays elongated .... Fam. *Macruridæ*.
  β: No distinct anterior dorsal fin. . Fam. *Ophidiidæ*.
b: Gill-openings small; branchiostegal membranes united by the skin of the body into a broad isthmus............. Fam. *Lycodidæ*.

FAM. **GADIDÆ.**

Body elongated, compressed, clavate or fusiform, and covered with thin cycloid scales. Caudal fin distinct from the other vertical fins[a]. *Jaws furnished with teeth. Gill-openings large; branchiostegal membranes more or less completely free from the isthmus. Pseudobranchiæ wanting, or glandular. Air-bladder and pyloric appendages generally well-developed.*

The Cod-family contains numerous forms: about 80 species, distributed among 25 genera, are known at present[b]. Almost all these forms are marine fishes, but the well-known Burbot-genus lives in fresh or brackish water. A great part of the marine fishes are deep-sea forms, properly so called, some of them descending to depths of about 2,000 fathoms, and all of them, like other forms of this nature, probably having a wide geographical range, even between the Tropics. The rest of the family, which frequent water of less depth, from the surface down to a depth of about 300 fathoms — though some of them have been found in 600 fathoms of water — are, almost all, inhabitants of the Frigid and Temperate Zones, only one genus belonging to the surface regions of the Tropics[c]. The development of the family is incomparably more diversified in the northern seas than elsewhere, and there the Cod-fishery has long been one of the most lucrative to the fishermen of many nations.

Of the peculiarities of the skeleton we have already remarked, in a comparison between this family and the preceding one, the lobate process on the upper (posterior) side of the intermaxillary bones, which in the Codfishes is especially well-developed, and generally renders these bones so easily recognisable (fig. 118, *l*). The nasal process (*n*) of these bones, on the other hand, is short; the snout being only slightly, if at all protrusile. The cephalic system of the lateral line is furnished with well-developed ducts and cavities in the bones belonging to the dermo-skeleton. In the occipital region we are particularly struck by the wide expansion of the styloid bone (*opisthoticum*), the bone with which the anterior end of the lower branch of the posttemporal bone articulates or coalesces, and which in this series is generally larger than the petrosal bone (*prooticum*) in front of it, or at least equal in size to the latter. The ventral fins are suspended from the inner surface of the anterior part of the clavicle by the anterior end of the pelvic bones. The vertebræ of the body are characterized by the marked and often singular development of their transverse processes. The first two vertebræ are generally without ribs; the first of all is often firmly united by its body and neural arch to the occipital bone. The following (2—5, generally 4) vertebræ are furnished with terete, wand-like ribs, curved as in the Cod, or straight as in the Hake, and articulating in distinct articular cavities with the bodies of

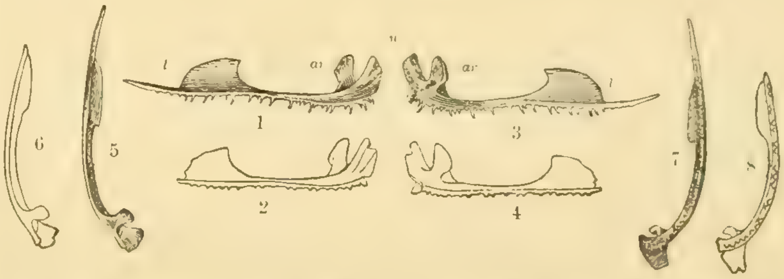

Fig. 118. Intermaxillary bones of the Polar Cod (*Gadus saida*), magn. 2 diam. 1, 3, 5, and 7 from a specimen 205 mm. long, from the White Sea; 2, 4, 6, and 8 from the Glacial clay at Lomma (Scania). 1 and 2 seen from the outside, 3 and 4 from the inside, 5 and 6 from above, 7 and 8 from below. *l*, the lobate process; *n*, the nasal process; *ar*, the articular process.

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[a] *Strinsia tinca*, an imperfectly known Mediterranean fish, described and figured by BONAPARTE as having confluent vertical fins, is generally included among the *Gadidæ*, but is referred by the characters mentioned above to the family *Macruridæ*, if it does not indeed turn out to be identical with *Uraleptus Maraldi*, a Gadoid fish with distinct caudal fin.

[b] In JORDAN and GILBERT's statement of 35 genera with about 90 species GÜNTHER's subfamily *Brotulina* of the family *Ophidiidæ* is included.

[c] *Bregmaceros*, with two species from India, New Zealand, the Philippine Islands, and China, as well as from the depths of the Gulf of Mexico.

the vertebræ. On the bodies of the vertebræ behind this point, transverse processes are developed, in front of or above the spot occupied by the articular cavity of the ribs, and the points of insertion for the ribs (where they are present) are transferred to these processes; while to the ribs or to the processes (in the latter case only behind) epipleural bones are attached. In the anterior part of the body the transverse processes gradually increase backwards, both in length and breadth; in the posterior part of the abdominal region they diminish backwards, until they finally curve downwards towards each other, and form the hæmal canal of the caudal region. Below these processes in the abdominal region, and united to their under surface, lies the large air-bladder, the protection of which is the purpose of their advanced development. Underneath they are more or less concave; or their margins may be bent downwards, as in the Arctic *Gadus navaga*, and united into a tube, closed on the outside. In this case a cucullate process of the air-bladder forces its way into each of the tubes, "foreshowing, as it were," says OWEN[a], "the pneumatic bones of the birds." Another osteological characteristic of the Codfishes lies in the circumstance that in the first abdominal vertebræ, the foremost of which is often closely united to the occipital part of the head, the neural spines are longer than in the following vertebræ, while in most fishes they are shorter. The Codfishes have another remarkable characteristic — the first rays of the anal fin (sometimes the whole of the first anal fin) are set under the abdominal cavity, their interhæmal spines lying loose among the ventral muscles, instead of joining the hæmal spines of the caudal vertebræ.

The Scandinavian fauna comprises the following genera of the Gadoid family:

I: Three dorsal fins and two anal fins	Genus *Gadus*.
II: Two dorsal fins and one anal fin:	
A: Anterior dorsal fin fully developed:	
a: Posterior dorsal fin and anal fin incised at the margin, and thus divided into an anterior, arcuate or rather straight part and a posterior, more lobate division. No barbels under the chin	Genus *Merlucius*.
b: Posterior dorsal fin and anal fin of more uniform height throughout, without incision at the margin. Chin furnished with a barbel:	
α: Ventral fins normal, with several rays:	
αα: Canine teeth interspersed among the jaw-teeth and the vomerine teeth	Genus *Molua*.
ββ: Jaw-teeth and vomerine teeth of uniform size and small	Genus *Lotta*.
β: Ventral fins apparently one-rayed, filamentous, and branched at the tip	Genus *Phycis*.
B: Anterior dorsal fin broken up into free, filamentous rays	Genus *Onos*.
C: Anterior dorsal fin rudimentary, with only 3 rays	Genus *Raniceps*.
III: One dorsal fin and one anal fin	Genus *Brosmius*.

Note. Divisions I, *a*, *α*, *β*, *B*, *C*, and III are regarded by some writers as distinct subfamilies: *Gadinæ*, *Merluciinæ*, *Lotinæ*, *Phycinæ*, *Motellinæ*, *Ranicipitinæ*, and *Brosmiinæ*, corresponding to the genera recognised by FRIES in the 1st edition of this work.

GENUS **GADUS**.

Three dorsal fins, all fully developed, and two anal fins. Peduncle (finless part) of the tail distinctly marked off. Ventral fins normal, with 6 rays. Jaw-teeth and vomerine teeth present. Branchiostegal rays 7.

KLEIN[b], who gave the genus the name of *Callarias*, was the first to characterize it with the limitations adopted above; but this was prior to the introduction of the Linnæan nomenclature. ARTEDI[c] had previously used the name which is now current, but with a wider application, comprising all the species of the Cod-family then known.

Fifteen or sixteen existing species of this genus are indubitably known[d], all of them belonging to the Northern Hemisphere. Though distinctly marine fishes, they sometimes choose to enter fresh water[a]. Strictly speaking, we can hardly call them deep-sea fishes; but some species descend to a depth of at least 500 or 600 metres. Their pronounced gregarious habits and their voracity make them an easy prey; and as the flesh of most of them is well-known for its wholesome qualities and good flavour, many of them are the objects of most productive fisheries.

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[a] *Anat. of Vertebrates*, vol. I, p. 38.

[b] "Ad *Callarias* nullum alium, cum probatissimis autoribus, admittimus piscem, nisi qui *dorsum* habet *tripterygium*." *Hist. Pisc. Miss.* V, p. 5.

[c] *Gen. Pisc.*, p. 19.

[d] GÜNTHER adopts and characterizes 18 species in his *Catalogue;* but of this number *Gadus macrocephalus* = *G. callarias*, *G. euxinus* = *G. merlangus*, *G. fabricii* = *G. saida*, and *G. productus* = a species of *Merlucius*. *Gadus ogak*, from Greenland, on the other hand, seems easy to distinguish from *G. callarias*, while *Gadiculus argenteus*, from the Mediterranean, the Bay of Biscay, and the Faroe Islands, has recently been shown to be a true *Gadus*.

The difference between the species of the genus is so slight that to divide it into subgenera, for which end several systems have been suggested, has hitherto proved almost impracticable. Still, the species compose several form-series, which, when we take into account the changes of growth, appear to be stages of development, more or less advanced in different respects, and issuing from a starting-point that has probably been common to this genus and the following one. The first series contains one species in the Scandinavian fauna, *Gadus poutassou*, which is without pyloric appendages, and thus comes nearest the Hake (*Merlucius merluccius*), which has only one appendage to the intestine. The Poutassou is also remarkable for the great length of the base of the first anal fin; and the history of development brings to light in the true Cods the general rule that the relative length of this fin decreases during the growth of the fish. In some of the species, however, the *Coalfishes* and *Whitings* for example, the length of the first anal fin is persistently at least more than half the distance between this fin and the tip of the snout; while in others the first anal fin invariably measures less than half this distance, this last group containing the true *Cods*. In two respects, which are indicated by different changes of growth of fair constancy, the Coalfishes and Whitings differ so greatly from each other that they may well be regarded as representatives of distinct groups in the system. The relative length of the snout increases with age, but that of the lower jaw decreases. In these respects the Coalfishes occupy a lower rank in the scale of development than the Whitings. Again, the Coalfishes and their allies are distinguished from the true Cods by the greater length of the lower jaw (a relatively shorter snout) in the former; and the Haddock, which in this respect (with the relatively longest snout) stands highest in the generic development, thus claims a group for itself in our fauna.

These series of forms may be arranged according to the following characters:

- I: Length of the base of the first anal fin less than half the distance between this fin and the tip of the snout:
  - *A:* Least depth of the tail at least about half (more than 49 %) of the length of the lower jaw... . .. ... *Gadus æglefinus.*
  - *B:* Least depth of the tail distinctly less than half (less than 46 %) of the length of the lower jaw:
    - *a:* Least depth of the tail more than 1/4 of the length of the pectoral fins or than 30 % of the length of the lower jaw:
      - *α:* Length of the head more than 1/4 of that of the body:
        - *αα:* Least breadth of the interorbital space more than 28 % of the length of the head.. *Gadus ogac.*
        - *ββ:* Least breadth of the interorbital space less than 28 % of the length of the head *Gadus callarias.*
      - *β:* Length of the head less than 24 % of that of the body:
        - *αα:* Length of the snout less than 2/3 of the postorbital length of the head; least depth of the tail more than 41 % of the length of the lower jaw......................... *Gadus gracilis.*
        - *ββ:* Length of the snout more than 68 % of the postorbital length of the head; least depth of the tail less than 40 % of the length of the lower jaw. . . . . *Gadus navaga.*
    - *b:* Least depth of the tail less than 23 % of the length of the pectoral fins or than 29 % of the length of the lower jaw............................. *Gadus saida.*
- II: Length of the base of the first anal fin more than half the distance between this fin and the tip of the snout:
  - 1: Length of the base of the first dorsal fin more than 30 % of that of the base of the first anal fin, and the length of the base of the second dorsal fin more than 50 % of the latter:
    - *A:* Upper jaw projecting beyond the lower jaw (length of the snout and the upper jaw-bone — distance between the tip of the snout and the

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[a] In Brown-Goode (*Fisheries and Fishery Industries of the United States*, sect. I. pp. 202 and 223) we find instances given of the presence in North American rivers both of the Cod and the Tomcod: and according to Malm the Cod makes its way up the River Gotha as far as Hising Bridge, and is taken not so seldom off the Public Iron Stores of Gothenburg, where it keeps to the salt water at the bottom of the river. In Day (l. c., p. 271) the Earl of Ducie gives some personal observations on this point from Norway. He says that the Pollack occurs in Midlungen and, together with the Cod and Green Cod, in Sörejde Fjord — like Midlungen a salt-water tarn with fresh water at the surface — and that at least the Pollack ventured up into the fresh water to bite.

hind extremity of either maxillary bone — more than 84 % of the length of the lower jaw):

- *a:* Length of the snout more than 8 % of the length of the body or than 75 % of the postorbital length of the head............... *Gadus merlangus.*
- *b:* Length of the snout less than 8 % of the length of the body or than 70 % of the postorbital length of the head:
  - *α:* Least depth of the tail more than 40 % of the length of the third dorsal fin............ *Gadus luscus.*
  - *β:* Least depth of the tail less than 33 % of the length of the third dorsal fin............ *Gadus minutus.*

B: Tip of the lower jaw projecting in front of the tip of the snout (length of the snout and upper jaw-bone less than 82 % of that of the lower jaw):

- *a:* Least depth of the tail more than half the distance between the tip of the snout and the hind extremity of the maxillary bones or than $^1/_3$ of the length of the third dorsal fin:
  - *α:* Length of the lower jaw less than 13 % of that of the body; length of the base of the first dorsal fin more than 75(85?)% of the length of the lower jaw *Gadus virens.*
  - *β:* Length of the lower jaw more than 13 (14?) % of that of the body; length of the base of the first dorsal fin less than 73 (70?) % of the length of the lower jaw.................. *Gadus pollachius.*
- *b:* Least depth of the tail less than half (43 %?) of the distance between the tip of the snout and the hind extremity of the maxillary bones or than $^1/_4$ of the length of the third dorsal fin.. *Gadus Esmarkii.*

2: Length of the base of the first dorsal fin less than $^1/_4$ of that of the base of the first anal fin, and the length of the base of the second dorsal fin less than $^1/_3$ of the latter.................... *Gadus poutassou.*

THE HADDOCK (SW. KOLJAN).

GADUS ÆGLEFINUS.

Plate XXII, fig. 1 and Plate XXIII, fig. 2.

Length of the base of the first anal fin less than half the distance between this fin and the tip of the snout. Upper jaw most prominent. Length of the lower jaw 35—40 % of that of the head. Least depth of the tail 50—60 % of the length of the lower jaw[a]. *One, short barbel under the chin. One, large, blackish spot on each side of the forepart of the body, just below the lateral line, which is dark or even black.*

R. br. 7; *D.* 14—17|20—24|19—22[b]; *A.* 21—25[c]|20—24[d]; *P.* 19—21; *V.* 6; *C.* x + 20—24 + x; *Vert.* 53—54.

Syn. *Aigrefin* l. *Aiglefin*, BELON., *Nat., Divers. Poiss.*, p. 118; *Gadus*, No. 7, ART., *Syn.*, p. 36; *Anon*, DUHAM., *Tr. Pêches*, part. II, sect. 1, p. 133, tab. XXIII, fig. 1; *Isa*, OLAFSEN, *Reise Isl.*, I, p. 357, tab. XXVI.

Gadus Aeglefinus, LIN., *Syst. Nat.*, ed. X, tom. I, p. 251; MOHR, *Isl. Naturh.*, p. 64; CUV. (subg. *Les Morues*), *Règn. Anim.*, ed. 1, tom. II, p. 212; FLMNG (*Morrhua*), *Brit. Anim.*, p. 191; NILSS. (subg. *Merlangus*), *Prodr. Ichth. Scand.*, p. 42; FR., EKSTR., v. WRIGHT (*Gadus*), *Skand. Fisk.*, ed. I, p. 86, tab. 19; STORER (*Morrhua*), Bost. Journ. Nat. Hist., vol. II (1839), p. 454; KR. (*Gadus*), *Danm. Fiske*, vol. 2, p. 42; NILSS., *Skand. Fn., Fisk.*, p. 550; GILL (*Melanogrammus*), Proc. Acad. Nat. Sc. Philad. 1862, p. 280 et 1863, p. 237; GTHR (*Gadus*), *Cat. Brit. Mus., Fish.*, vol. IV, p. 332; MGRN, Öfvers. Vet.-Akad. Förh. 1864, p. 529; COLL., Vid. Selsk. Forh. Christ. 1874, Tillægsh., p. 108; ibid., 1879, No. 1, p. 66; WINTH., Naturh. Tidskr. Kbhvn, ser. 3, vol. XII (1879), p. 28; MOR., *Hist. Nat. Poiss. Fr.*, tom. III, p. 237; DAY, *Fish. Gt. Brit., Irel.*, vol. I, p. 283; JORD., GILB., Bull. U. S. Nat. Mus., No. 16, p. 803; MÖB., HCKE, *Fisch. Osts.*, p. 75; LILLJ., *Sv., Norg. Fisk.*, vol. II, p. 54; BR. GOODE (*Melanogrammus*), *Fisher., Fisher.-Industr. U. S.*, Sect. I, p. 223, pl. 59, *A*; HANSEN (*Gadus*), *Zool. Dan., Fiske*, p. 67, tab. IX, fig. 4.

Aeglefinus Linnei, MALM, *Gbgs, Boh. Fn.*, p. 481.

Obs. Owing to its short lower jaw the Haddock, as we have mentioned above, ranks as a type quite distinct from the rest of the Scandinavian Codfishes, but in this respect perhaps coincides with the American Tomcod in the west of the Atlantic. In this case the latter species, with its widely separated dorsal and anal fins, bears the same systematic relation to the former as the Polar Cod and *Gadus navaga* to the Common Cod. GILL gave the Haddock the generic name of *Melanogrammus*, with reference to the black, lateral spot — cf. above, p. 308, on the Dory. But the division represented by the Haddock has no more right to a special generic name than any of the other groups of the genus *Gadus*, as it was defined by FRIES (l. c.). The elongation of the snout and the reduction of the lower jaw are results of changes of development common to the Haddock and the other species of the genus; but the Haddock has advanced furthest in this course of development; and we, therefore, place it first in the series. How the changes of growth in this respect express a common direction of development, appears from the following table, in which we have summarized the results of our measurements of specimens belonging to the Royal Museum:

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[a] In Haddock fry from Spitzbergen, taken in Ice Fjord in September, 1861, 35 mm. long, I find the length of the lower jaw to measure 45 % of that of the head, and the least depth of the tail $46^1/_2$ % of the former. The latter percentage might indeed, to the best of our knowledge, be of some use as a specific character; but the corresponding percentage in old specimens of *Gadus navaga* comes too near it. Thus the above given character based on these two points must be used with precaution.

[b] Sometimes 23, according to KROYER.

[c] ,, 26, ,, ,, ,,

[d] ,, 25, ,, ,, ,,

			Length of the body in millimetres	Length of the snout in % of that of the lower jaw.
Haddock Group	*Gadus æglefinus*	average in 3 specimens	414	103.8
		in 1 specimen	72	77.5
Cod Group	*Gadus ogac*	in 1 specimen	490	73.7
		„ 1 „	388	68.1
		„ 1 „	294	67.5
	Gadus callarias	average in 4 specimens	266	73.5
		„ „ 5 „	176	64.0
	Gadus gracilis	average in 2 specimens	346	77.0
	Gadus navaga	„ „ 3 „	192	76.2
	Gadus saida	average in 3 specimens	210	55.1
		„ „ 4 „	130	54.0
Whiting Group	*Gadus merlangus*	average in 2 specimens	409	73.6
		„ „ 4 „	326	72.1
		„ „ 2 „	139	71.4
	Gadus proximus	in 1 specimen	178	69.0
		average in 2 specimens	164	62.5
	Gadus luscus	in 1 specimen	319	63.0
		average in 2 specimens	298	58.3
	Gadus minutus	average in 2 specimens	189	59.7
		„ „ 2 „	143	57.6
Coalfish Group	*Gadus virens*	average in 2 specimens	298	69.3
		„ „ 3 „	105	65.1
	Gadus pollachius	average in 3 specimens	362	58.9
		„ „ 3 „	204	56.0
	Gadus Esmarkii	average in 2 specimens	180	55.0
		„ „ 3 „	127	50.3
Poutassou Group	*Gadus poutassou*	in 1 specimen	395	58.8
		„ 1 „	359	56.2
		„ 1 „	115	51.2

It is evident from this table, first that in the same species the percentage is generally lower in young specimens than in older ones, and second, that in the species that occupy the lowest rank in each of the above groups of the genus, the percentage is also lower than in the others. The former species are also distinguished by their smaller size. However, the intermediate forms between the groups are so numerous, especially in the character given here, that even though we are able to distinguish between different series of development, these series are still best included in the same genus, especially as the most important specific characters lose a great portion of their validity when young specimens are in question.

The average length attained by the Haddock in Scandinavia is between 30 and 50 cm. The largest specimen from Bohuslän that came under MALM's observation, was 79 cm. long. FRIES was informed, how-

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[a] In another specimen, 730 mm. long, we find a reversion to the juvenile characters, this percentage being 68·8, while in another, abnormal (macrocephalic) specimen, 212 mm. long, it is 81·1.

[b] A Pacific species (with range extending from California to Alaska) which combines the characters of *G. luscus* with those of *G. minutus* — distinguished from both by the base of the second dorsal fin measuring less than half the distance between the tip of the snout and the first anal fin — but more nearly related than either to *G. merlangus*.

[c] In another specimen, 210 mm. long, we find a reversion to the juvenile characters, the percentage in question being 53·0.

ever, by the fishermen of Bohuslän that they had seen Haddocks 89 cm. or more in length[a].

The body is of the normal Gadoid form, being usually somewhat deeper than that of the Common Cod. The greatest depth varies between 21 or (generally in the males) 20 and 23 % of the length. The least depth of the body is also, in most specimens, somewhat greater than in the Cod, varying between 5 and $5^1/_2$ % of the length. On the other hand, the body is generally rather more compressed, the greatest thickness varying between 55 (sometimes 54) and 61 % of the greatest depth. The dorsal profile slopes from the first dorsal fin to the occiput, and joins the forehead, which bends slightly down towards the snout, in a regular, gradual curve.

The head is of a singular form, characteristic of this species[b]. The under surface is perfectly flat when the mouth is closed, the lower jaw, the projecting margin of the upper jaw, and the inferior margin of the still more prominent snout lying in the same plane, and the slightly curved frontal profile sloping in a wedge-shape towards the snout. The snout is somewhat pointed[c], but broader than high, and quite thin, and projects as far in front of the tip of the upper jaw as the latter beyond the lower jaw. With the exception of the extreme margin, which is visible, the whole of the upper jaw lies in a deep dermal fold under the snout[d]. The upper jaw is comparatively short, its hind extremity falling short of the perpendicular from the anterior margin of the eye, or, at all events, extending only just behind it. The distance from the tip of the snout to the end of the maxillary bones is about 9 or 10 % of the length of the body, but to the best of our knowledge does not exceed the latter proportion. The eyes are comparatively large, their length in full-grown specimens being very nearly $^1/_4$ of that of the head. They are set high, their inferior margin lying somewhat above the line from the point of the operculum to the margin of the upper jaw, and their upper margin almost in the same plane as the forehead. The distance between them is about equal to their diameter; and the centre of the eye almost coincides with the middle point of the length of the head. The nostrils lie in a small depression somewhat behind the middle of the snout, one on each side just in front of and a little above the other. The posterior opening on each side is large, oval, and open, with only the upper anterior part of the margin raised in a lobate form; the anterior is smaller, with a more tubular orifice, the lower posterior part of the margin being furnished with an upright, triangular flap. The lips are fairly thick, and envelop the margins of both jaws. The gape is small, its length being about $^1/_3$ of that of the head; it is turned obliquely downwards when the mouth is opened and the upper jaw protruded. In both jaws and on the head of the vomer we find rather small and short, pointed, recurved teeth, in the upper jaw (on the intermaxillary bones) set in several, close rows, but in the lower, strictly speaking, in only two, of which the inner one is often hardly perceptible. The tongue is somewhat pointed, with free tip. The gill-openings are middle-sized. The branchiostegal membranes are inferiorly united to each other in the form of a collar. The branchiostegal rays are, as usual, 7. Under the chin we find a small, conical barbel, with fine tip. Its length is less than the diameter of the eye.

The whole body, out to the very snout, is covered with small, thin scales, which are generally invisible during the life of the fish, being then coated with slime. These scales also cover a great portion of the caudal fin and the bases of the dorsal fins, especially in front, and of the pectoral fins. Some traces of scales also appear on the front parts of both anal fins. The lateral line starts from the temporal region, on a level with the upper margin of the eye and in a scarcely perceptible curve, and below the second dorsal fin descends evenly, thus occupying the middle of the side vertically below the beginning of the third dorsal fin, from which point its course is straight. It is strikingly broad and depressed, with the margins of the groove swollen, as it were. The vent is situated somewhat in front of the middle of the body, below the beginning of the second dorsal fin, the distance between it and the tip of the snout being about 38—41 % of the length of the body.

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[a] Statements from England and North America show that the Haddock may attain a much greater size. Olsen (*Piscatorial Atlas*, pl. 17) gives 16 lbs. as the maximum weight of the Haddock. Day mentions a specimen that was caught in Dublin Bay, and was 37 in. in length and $24^1/_4$ lbs. in weight. Storer (Mem. Amer. Acad. Arts, Sc., vol. VI, p. 357) states the maximum weight of the Haddock at 17 lbs., and Earll (see Brown-Goode, l. c.) found the weight of a gravid female $28^1/_2$ inches long to be 9 lbs. 9 oz.

[b] In full-grown specimens the length of the head is about $^1/_4$ of that of the body. In fry between 35 and 70 mm. long we have found the length of the head to be 27 or 28 % of the length of the body.

[c] Its relative length, on the other hand, is the same as in the Common Cod, varying between about $8^1/_2$ and 10 % of the length of the body.

[d] Gesner (*Hist. Anim.*, lib. IV, p. 86 — Frankfort, 1620) describes the form of the snout as *rostrum aquilinum*, and suggests the latter word as the derivation of the name of *aiglefin*. At Dieppe, however, the Maigre (*Sciæna*) is also known as *aigle*, and *aiglefin* may perhaps be due to some fancied likeness between this fish and the Haddock. Belon had already declared that it was impossible to discover any satisfactory etymology of *aiglefin*.

The pectoral fins contain 2 simple and 17—19 branched rays. The 4th and 5th rays are the longest, the following ones gradually decreasing in length, and the last rays very small and difficult to distinguish. The length of the fins is about 16[a]—$17^1/_2$ % of that of the body, and their tips extend to a line with the vent. The ventral fins are pointed, and in old specimens cover slightly more than half the distance between their bases and the beginning of the first anal fin. In young specimens they are comparatively larger, their length being sometimes as much as 81 % of this distance. They are made up of 6 rays, the first two simple, with long, free tips, and the second the longest.

The first dorsal fin begins above the base of the pectoral fins, at a distance from the tip of the snout equal to 28—30 % of the length of the body; and its base measures about 13 % of the length of the body. It is triangular in shape, with a fairly acute angle, and is higher than either of the other two dorsal fins. It contains from 14 to 17 rays, the first two simple, the second the longest, measuring between about $15^1/_2$ and $18^1/_2$ % of the length of the body, and the remaining ones decreasing rapidly in length. The anterior margin of the second dorsal fin, which has the longest base — measuring about 21—$22^1/_2$ % of the length of the body, leans backwards, forming a somewhat obtuse angle with the straight, sloping, superior margin. This fin is made up of from 20 to 24 rays, the fifth and sixth being the longest and comparatively longer in young specimens than in old, and of a length varying between 14 and about 10 % of that of the body, or about equal to that of the ventral fins. The third dorsal fin is of almost the same shape as the second, but shorter, its length being about $14^1/_2$—$15^1/_2$ % of that of the body, and somewhat more pointed at the anterior corner. It consists of from 19 to 22 rays, the fourth or fifth being the longest, and measuring about 10—8 % of length of the body.

The first anal fin differs but slightly from the second dorsal. It begins somewhat further back, the distance between it and the tip of the snout, compared with the corresponding distance in the case of the second dorsal fin, is as 10 to 9·8 or 9·3; and the anterior corner is much more rounded. It contains from 21 to 25 rays, the first five or six simple at the tip, and the third generally the longest. The resemblance is still greater between the second anal fin and the third dorsal. The former consists of between 20 and 24 rays, the first two simple, and the third the longest.

The caudal fin is normal in form, somewhat incised at the tip, but not far from truncate when expanded. The length of its middle rays diminishes during growth from about $8^1/_2$ to $6^1/_3$ % of that of the body.

The difference in colour between a live (Plate XXII, fig. 1) and a dead Haddock (Plate XXIII, fig. 2) is considerable. The latter is of a plain, dirty gray above and white below, with black lateral line. In the living fish, on the other hand, the upper part of the head and the back are of a dark gray, violet colour, which as it passes into the lighter, silver-gray colour of the sides assumes a handsome, light, coppery lustre of marked brilliancy. The belly, the lower portion of the head, and the tail are milk-white. The sides are silver-gray, shading into yellow at the top and below thickly strewn with fine, blackish dots. The lateral line is yellowish black, but darker at one moment and lighter at another. The iris is blackish gray, with a dark shading of yellowish tinge above and below the pupil. A marking especially characteristic of the Haddock is the large, blackish spot that lies just below the lateral line in the neighbourhood of the first dorsal fin. It is constantly present, in all specimens of all ages, but may be more or less distinctly prominent. The shape of this spot is very irregular and variable. The superior fins, as well as the pectoral fins and the caudal fin, are of the general colour of the back, with lighter, yellowish bases. The anal fins are silver-gray, with milk-white base, strewn with numbers of black dots, and lighter margin. The ventral fins are milk-white, the membrane between the branched rays punctated with black.

The structure of the internal organs is essentially the same as in most of the Codfishes; and as it is our intention to give a more minute description of these organs in the Whiting, we need only point out for the present that the abdominal cavity extends back to about the middle of the body, or to a distance beyond the vent equal to the length of the ventral fins. The second (hind) coil of the intestine (the first coil is not half so long) and the long, left lobe of the liver extend to the bottom of the cavity. The peritoneum is ashy gray. The air-bladder is large, broad behind, and furnished with large, firm lateral bands, projecting from it like the teeth of a saw. The liver has numerous small lobes, but as usual only two principal ones, the left being the longer, and one, shorter, middle lobe. The gall-bladder is oblong, with pointed bottom and very thin membrane. The pyloric appendages are narrower and longer than in the Whiting. Their number may rise to about 200.

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[a] Sometimes 15, according to Krøyer.

The chief singularity in the skeleton of the Haddock is that the clavicular bones are terete, swollen, as it were, in their anterior (horizontal) part, but pointed as usual — as OLAFSEN describes them: "thick, oblong, round, white, and very easily worked, but much softer and looser than ivory. The Icelanders make various trifles out of them, mostly chess-men, which they dye green with oxide of copper". The posterior (angular) part of the posttemporal bone is also swollen.

The Haddock is an Atlantic species, but seems to prefer the eastern parts of this ocean. Still, it is by no means rare on the east coast of North America — between lats 38° and 53° N., according to BROWN-GOODE — and is taken there, occasionally at least, in greater numbers even than the Cod. But on that side of the Atlantic its range, as far as we know it, is beyond comparison more confined than on this, where it occurs from about lat. 78° to 44° N. KRØYER observed it "about 13 miles off Spitzbergen, in about lat. 77° N."; and the Swedish Expedition of 1861 took a small young Haddock (see above) in a trailnet in Ice Fjord. The Spitzbergen Expedition of 1868 paid a visit of some days to Bear Island; and at the anchorage of the *Sofia* on the east side of the island the crew caught numbers of Haddocks with handlines. MELA[a] states that the Haddock is common on the Murman coast, and thinks it probable that the species occurs in the White Sea. In Iceland, according to FABER[b], it is very valuable to the inhabitants. On the coast of Greenland it is unknown. The Haddock-fishery is pursued along the whole Atlantic coast of Europe, down to central France; but in the Bay of Biscay, according to MOREAU, the Haddock is rare, and further south, as well as in the Mediterranean, it is unknown. Along the whole coast of Norway and the west coast of Sweden down to the Sound the Haddock is common, but south of Hveen it is rare, and, as NILSSON points out, has never been caught on the Baltic coast of Sweden. On the German coast it has never been found east of the coast of Mecklenburg; but it is sometimes found in Kiel Bay, where, according to MÖBIUS and HEINCKE, specimens 60 cm. long have been taken.

The Haddock likes fairly deep water — according to MALM, from 12 to 50 fathoms in depth — with a clayey or soft sandy bottom, which it always hugs closely. Though always a shore-fish, it is by no means stationary, but keeps roving about in large or small companies along the deep channels among the island-belt, the younger specimens in large shoals, the older in smaller ones. Thus, one can never be sure of finding this fish at spots where it has formerly been plentiful, nor, though one has made a good catch on one day, of taking a single specimen on the morrow. The Haddock is never seen quite close in shore, not even the fry; and the seasons seem to influence it but little in the choice of its haunts. KRØYER has already remarked that off several parts of the Danish coasts the Haddock has disappeared for years, and then returned. NILSSON makes the same remark of Kullen, where it is said to be plentiful periodically, every eighth or tenth year. Numbers of similar observations have been made in America[c]. The causes of these migrations may be various; but one of the most probable explanations of the periodical abundance or scarcity of the Haddock seems to lie in the needed supply of food. Like its kindred species, the Haddock is a fish-of-prey that lives on other fishes; but it is also very fond of lower organisms, shellfish, worms, and *Ophiuræ*, which induce it to make its home on soft bottoms. Its comparatively small mouth naturally restricts its voracity; but when the young Herrings enter the shallower inlets among the islands, the Haddock joins their pursuers, and is thus enticed into shallower water than it usually frequents. On these occasions a few Haddocks are taken in the Herring-seines.

[a] *Vert. Fenn.*, p. 299, tab. IX.

[b] *Naturg. d. Fische Islands*, p. 103.

[c] See BROWN-GOODE, l. c.

The Haddock spawns in spring, from February or March to May or June[a]. The ripe eggs, which are developed floating about in the sea, are $^1/_9$ of an inch (2·82 mm.) in diameter, according to EARLL, and increase in number according to the age of the parent-fish, a female 49 cm. long and 1·08 kgm. in weight containing about 170,000, and one 72 cm. long and $4^1/_3$ kgm. in weight about 1,839,600. In September, off Spitzbergen, the fry are about 35 mm. long, if any conclusion may be drawn from our observation on one single occasion; but even on the 14th of June COLLETT found Haddock-fry 40—50 mm. long in Christiania Fjord, and YARRELL[b] states that on the coasts of England "the young are six inches long by the beginning of September." In October and November, says FRIES, some small Haddocks between 100 and 150 mm. in length may occasionally be taken on the coast of Bohuslän; but with this exception the fry are never seen. Like the young of several other fishes, of the Horse Mackerel (see above, p. 87) and the Cod for example, the Haddock-fry, according to SARS and COLLETT, seek shelter and food under the bodies of *Medusæ*, together with which they drift about, until they are more than 50 mm. long; and then they probably join their parents in deeper water. Off Tromsö, however, LILLJEBORG saw fairly large shoals of young Haddocks keep near shore in from 4 to 6 fathoms of water.

The flesh of the Haddock is excellent, though its reputation varies very greatly in different localities and at different seasons. In England and in Scandinavia middle-sized specimens, between $^1/_2$ and 1 kgm. in weight, are considered best. In Ireland the largest specimens are most highly esteemed. During the spawning-season the Haddock, like other fishes, is not so good eating. It is consumed fresh — a boiled Haddock is a dish of good flavour and easy of digestion — or also salted or dried. In England it generally makes its appearance on the table of the well-to-do at breakfast, smoked and broiled. The Scotch "Haddies" of Findon, near Aberdeen, enjoy a great reputation. After the fish is gutted, it is soaked for about three hours in brine and then hung in the smoke of burning peat and sawdust, but only until it acquires the proper, yellow colour. It is, thus, very lightly smoked, but has a peculiar and not at all unpleasant flavour. Next to the Herring, too, the Haddock is the most important salt-water fish to the English fisherman. In 1888, in England, Scotland, and Ireland, no less than 2,369,012 cwt. of Haddock were taken, of a value of £943,258[c]. In Bohuslän, to judge by the average prices at Gothenburg[d], the Haddock sells best from September to April inclusive, when it fetches about 1·60 to 2·30 crowns (1/9—2/6) a score. In 1879 nearly two million Haddocks were brought to Gothenburg, most of them in November and April. In Bohuslän the Haddock is of more importance to the fisherman than merely as an article of food. It is chiefly this fish that is used as bait in the *storfiske* (great-fishery) for large Cod and Ling.

The most productive method of fishing for Haddocks practised in Sweden is with *småbackor* (small long-lines) or, as they are also called, Haddock-lines, about 125 metres long, with 100 hooks attached to snoods about 45 cm. long[e]. These lines are set in a continuous line ("link") one after another in deep water near shore, at spots where the Haddocks come roving in large shoals. They generally lie only a very short time, for when the fisherman has paid out the last bit of the *link*, he proceeds to take up the other end. A bait of mussels (*Mytilus edulis*) is usually employed. During the whole summer this fishery is carried on, in order to provide bait for the large long-lines set for Cod and Ling. But even after the latter fishery is over, Haddock-lines are set on the west coast of Sweden all the autumn and far into the winter, and repay by the abundant catch the toil and difficulties which the fishermen must brave to set them. The spots chosen at this season are generally in about 30 fathoms of water, between 10 and 15 kilometres from shore, and the hooks are baited with small Herrings or Sprats, which the Haddock likes best of all, until February, when a bait of shellfish is again adopted. When the weather permits, the lines are taken up as soon as they are set, but they often lie longer if the fisherman is driven by storm or hard weather suddenly to make for land. This always lessens the catch. The Myxine (*Myxine glutinosa*) now seizes its opportunity, creeps into the hooked Haddock either through the mouth or the vent, and devours the flesh down to the bones without touching or damaging the skin.

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[a] EARLL (see BROWN-GOODE, l. c.) found a female that had not yet spawned, as late as the middle of July. OLSEN (*Piscat. Atl.*) states that in England the spawning-season extends over February, March, and April. EWART describes (*Nature*, 1889, May 2nd, p. 15) how SCOTT met with a large shoal of Haddocks spawning at the bottom in about 30 fathoms of water, about 15 miles off the coast of Banff. The surface teemed with floating eggs of almost every stage of development, both of the Haddock and the Cod. At a single sweep with his tow-net he secured half a million eggs, while the trawlers brought hundreds of spawning fish from deep water.

[b] *Hist. Brit. Fish.*, ed. 2, vol. II, p. 234.

[c] See *The Fish Trades Gazette* for the 12th and 26th of January, 1889.

[d] v. YHLEN, *Die Seefischerei an der Westküste Schwedens.* Appendix to the catalogue of the Swedish department of the Berlin Exhibition, 1880.

[e] A description of this fishery, as it is pursued in the North Sea, on the German coast and off Heligoland, is given by DALMER in MAX V. D. BORNE'S *Handbuch der Fischzucht und Fischerei*, p. 494.

The Haddock is also taken on hand-lines (*dörj*) all the year round, in the same way and at the same time as Whiting, if one only chooses the deep channels. The best bait is invariably the flesh of the mussel, but it sometimes happens that the Haddock bites, though far from readily, at a piece of Whiting. The bait should lie on the bottom, while for Cod and Whiting the line should be held so as to keep the bait a little way from the bottom. More experience is required, however, in fishing for Haddocks with a hand-line, for this fish makes sudden and violent struggles to free itself from the hook, and its mouth is looser and more easily torn than that of the Whiting. In this way the fisherman loses a great part of his fish while drawing them up. Most of the Haddocks caught in the North Sea are taken in the trawl; but the flesh of the Haddock is soft enough before, and after it has been tossed about in the trawl among other fish and stones, it can never be so good as that of the Haddocks taken on the hook.

(Fries, Smitt.)

THE COMMON COD (SW. TORSKEN).

GADUS CALLARIAS.

Plate XXII, figs. 2 and 3; Plate XXIII, fig. 1.

Length of the base of the first anal fin less than half the distance between this fin and the tip of the snout. Upper jaw most prominent. Length of the lower jaw at least about 46 % of that of the head. Least depth of the tail at most about 42 % of the length of the lower jaw, but at least about 30 % of the length of the pectoral fins. Length of the head at least about 25 % of that of the body, and the least breadth of the interorbital space at most about 25 % of the length of the head. Lateral line whitish and curved. Caudal fin truncate. Coloration gray, green or red, more or less spotted but without any especially prominent, black spot on the sides.

R. br. 7; *D.* 12—15 16—20 16—20; *A.* 17—20 16—19; *P.* 18—21; *V.* 6; *C.* x + 23—27 + x; *Vert.* 51—54[a].

Syn. *Asellus major* (p. 18) + *Asellus varius vel striatus* (p. 19) + *Asellus nanus* (p. 20): Schonev., *Ichthyol. Slesv., Holsat.* = Asellus major vulgaris (p. 165) + Asellus varius vel striatus Schonfeldii (p. 172); Willugh., *Hist. Pisc.* — *Gadus*, No. 4 et 6, Art., *Syn. Pisc.*, p. 35 = Lin., *Fn. Suec.*, ed. I, No. 293 et 295.

Torsk, Lin., *It. Öl.*, p. 87; *Kabbeljå* + *Torsk*, *It. Westr.*, p. 176 et 177; *Tarsken*, *It. Scan.*, p. 220.

Gadus Callarias, Lin., *Syst. Nat.*, ed. X, tom. I, p. 252; Retz., *Fn. Suec. Lin.*, p. 318; Cuv., *Règn. Anim.*, ed. 2, tom. II, p. 332; Pall., *Zoogr. Ross. Asiat.*, tom. III, p. 182; Nilss., *Prodr. Ichthyol. Scand.*, p. 40; Ekstr., Vet.-Akad. Handl. 1834, p. 38; Schagerstr., Physiogr. Sällsk. Tidskr., p. 297; Ekstr. et v. Wright, *Skand. Fisk.*, ed. I, p. 191, tab. 47; Sundev., Stockh. L. Hush. Sällsk. Handl., II. 6 (1855) pp. 82, 94, 166; Nilss., *Skand. Fn., Fisk.*, p. 537; Jord., Gilb., Bull. U. S. Nat. Mus., No. 16, p. 804; Lillj., *Sv., Norg. Fisk.*, vol. 2, p. 31; Hansen, *Zool. Dan., Fiske*, p. 57, tab. IX, fig. 1.

Gadus Morhua, Lin., *Syst. Nat.*, l. c.; Retz. (*G. morrhua*), l. c.; Cuv., l. c., p. 331; Pall., l. c., p. 181; Nilss., *Prodr.*, p. 39; Fr., *Skand. Fisk.*, ed. I, p. 78; Kr., (*G. Morhua*) *Danm. Fiske*, vol. 2, p. 1; Nilss. (*G. Morrhua*) *Fn.*, l. c.; Gthr, *Cat. Brit, Mus., Fish.*, vol. IV, p. 328; Mgrn, *Finl. Fisk.* (disp. Helsingf.) p. 27; Öfvers. Vet.-Akad. Förh. 1864, p. 528; Lindstr., Gotl. L. Hush. Sällsk. Årsber. 1866, p. 21 (sep.); Coll., Forh. Vid. Selsk. Christ. 1874. Tillægsh., p. 103; ibid. 1879, No. 1, p. 65; N. Mag. Naturv., Bd. 29 (1884), p. 81; Malm, *Gbgs, Boh. Fn.*, p. 480; Winth., Naturh. Tidskr. Kbhvn, ser. 3, vol. XII (1879), p. 27; Bncke, *Fisch., Fischer., Fischz. O., W. Preuss.*, p. 87; Mor., *Hist. Nat. Poiss. Fr.*, tom. III, p. 235; **Mela**, *Vert. Fenn.*, p. 298, tab. IX; **Day**, *Fish. G:t Brit.*, *Irel.*, vol. I, p. 275, tab. LXXVIII; **Möb.**, **Hcke**, *Fisch. Osts.*, p. 72; **Br. Goode**, *Fisher.*, *Fischer. Industr. U. St.*, sect. I, p. 200, tab. 58, A.

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[a] The latter number according to Malm.

Gadus barbatus (p. p.) **Lin.**, *Syst. Nat.*, l. c.

Gadus ruber, **Lacep.**, *Hist. Nat. Poiss.*, vol. V, p. 671; **Hollb.**, *Bohusl. Fisk.*, H. II, p. 31 c. tab.

Gadus macrocephalus, **Til.**, Mém. Acad. Imp. Sc. Petersb., tom. II (1807 et 1808), p. 350, tab. XVI et XVII.

Morrhua Americana, **Storer**, Bost. Journ. Nat. Hist., vol. II (1838—1839), p. 448; Mem. Amer. Acad. Arts, Sc., n. ser., vol. VI (1859) p. 343, tab. XXVII, fig. 4.

Obs. As we see by the above list of synonyms **Willughby** and, after his time, **Artedi** adopted only two of the three species that **Schonevelde** imagined he could distinguish in our Common Cod. In his description of the first of them, *Asellus major*, **Willughby** writes: *Cauda plana fere et minime forcipata: primus radius primæ ab ano pinnæ brevis est et spinosus.* This appeared in **Artedi** as: *Gadus . . . . cauda æquali fere cum radio primo spinoso*, which **Linnæus** corrected to: *cauda subæquali, radio primo anali spinoso.* This confusion between a simple but articulated (soft) ray and a spinous ray was long accepted, on **Linnæus**'s authority[a], in combination with changes of growth, as a distinction between the Great Cod (Sw. *kabiljo* — *morhua*, *morue* in **Belon**) and the Lesser (young Cod and Baltic Cod — *callarias*). The name of *Gadus morrhua* is thus to be rejected as based on an error; and that of *G. callarias* must therefore be recognised as the only right one, especially as it is of classical origin, though the ancient Greeks could not possibly have applied it to the Cod, which is not a Mediterranean fish. The first to reject the above character was **Faber**[b]; but, like **Nilsson**[c], who avoided making any reference to this character, he accepted the species as distinct. It was **Fries**, in the former edition of this work[d], who first joined these hypothetical species into one, which he called "*Torsken, G. Morrhua*" in the systematic distribution of this genus. He had been led to this conclusion in 1838 by his observations in the island-belt of Bohuslän, observations which were subsequently pursued and verified by **Ekström**. The latter summed up his results as follows: the form previously called *Gadus morrhua* really consists only of older specimens, and the *Gadus callarias* of former writers of young specimens of the same species, which in shallower and not so salt water, however, as in the Baltic, never attain a size that quite matches that of a full-grown Cod from the North Sea. A short time before **Ekström** suggested this explanation, **Krøyer** in *Danmarks Fiske* had discussed this question at length and come to the same result.

The usual size of the Common Cod taken within the island-belts on the coast of Scandinavia is about 6 dm. Those which are caught on banks in the open sea are larger, and pretty frequently attain a length of 12 dm. and a weight of about 17 kgm. Specimens of this size enter the Sound, according to **Schagerström**, and the south-west of the Baltic, according to **Möbius** and **Heincke**. The largest specimen from Kiel Bay that the latter writers had seen, weighed 19 kgm. Much larger Cod are, however, on record, and **Brown-Goode** gives instances from America in which the weight was as much as $72^{1}/_{2}$ kgm. The Cod may attain this size on the brink of the ocean depths, but in Scandinavia it probably never grows so large. The largest specimen **Krøyer** had seen on the Lofoden Islands, was nearly 25 kgm. in weight and about 140 cm. long[e]. Like other true marine fishes it is somewhat stunted in growth in the Baltic; but even in the south of the Gulf of Bothnia, off Östhammar, **Lilljeborg** found Cod 675 mm. long and $3^{1}/_{2}$ kgm. in weight. In Baggen Fjord, in the inner island-belt of Stockholm, the species attains a length of at least 600 mm.[f]

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[a] **Schagerström** has also fallen into this mistake. He saw, however, that in both the "species" the anal fins were exactly alike in this respect.

[b] *Naturg. Fisch. Islands*, p. 105.

[c] *Prodr.*, l. c.

[d] *Skand. Fiskar*, 1st Ed., p. 78.

[e] According to **Earll** (Rep. U. S. Fish. Comm. 1878, pp. 733—4) the following proportions exist in the Cod between the length and the weight:

a) in the males

length varying between	42	and	80	cm., average length	694	mm., average weight	3·2	kgm.
,, ,, ,,	84	,,	90	,, ,, ,,	867	,, ,, ,,	5·9	,,
,, ,, ,,	91	,,	117	,, ,, ,,	1,010	,, ,, ,,	9·7	,,

b) in the females

length varying between	47	and	80	cm., average length	674	mm., average weight	2·4	kgm.
,, ,, ,,	81	,,	93	,, ,, ,,	868	,, ,, ,,	6·1	,,
,, ,, ,,	94	,,	113	,, ,, ,,	1,031	,, ,, ,,	9·46	,,
,, ,, ,,	114	,,	146	,, ,, ,,	1,280	,, ,, ,,	19·22	,,

The smallest male was 42 cm. long and weighed 0·57 kgm.; the largest female 146 cm. long and 24·5 kgm. in weight.

[f] In his "*Gotlands Fiskar*" (l. c., pp. 26, seq.) Professor **Lindström** directs attention to the so-called *Doomsday Fish* which has hung for several centuries in Wisby Cathedral, and the history of which, as told by **Braunius** (end of the 16th century), **Bertius** (1616), and **Strelow** (1633), was summed up by **Haquin Spegel** (*Rudera Gotlandica*, Mss.) at the end of the 17th century as follows: "In the year 1289 a large and rare fish was caught off Wisby, in the belly of which a new-born, living child was found that cried and screamed loudly. The fish was hung up in St. Mary's Church, and a portion of it seems still to be preserved." **Linnæus** mentions it in his "*Ölands och Gotlands Resa*" (p. 165): "The fish that was hung in the same church over the picture of St. George, was a *Piscis malacopterygius, cauda bifurca, pinnis dorsi duabus, ani unica, cum altera intra hanc et caudam, e regione posterioris pinnæ dorsalis;* the ignorant folk said that of this fish it was prophesied that the Day of Judgment should come when it had rotted away, and therefore could not be far off." By the kind permission of the Chapter of the Cathedral we have been enabled to examine the existing remains of this fish, consisting of eighteen caudal vertebræ, a few rays from the posterior dorsal or anal fins, some of the interspinal bones, and a piece of dried flesh, all of which —

The body is only slightly compressed, deepest and broadest at the beginning of the first dorsal fin, from which point it tapers sharply towards the caudal fin. The back is almost straight and terete, the belly also terete, but more or less pendent, especially in the female. The greatest depth of the body is generally even relatively greater in old specimens than in young, and varies between about 16 and 21 % of the length. In the quite common, macrocephalic, deformed specimens — with the length of the head sometimes as much as 38 % of that of the body — the depth is also excessively great, in some cases about $^1/_3$ of the length of the body. The greatest breadth is about $^2/_3$ (60—75 %) of the depth[a].

The head is comparatively large and wedge-shaped. Its relative length generally increases with age from about $^1/_4$ to nearly $^1/_3$ of the length of the body[b]; and it is only during the first part of its growth, till it attains a length of about 100 mm., that the Cod follows the general rule that the relative length of the head decreases. The forehead is flat. A deep groove in the occiput, deepest in fat and robust specimens, extends almost to the beginning of the first dorsal fin. The eyes are round, with oval orbits, and large, but their relative size diminishes considerably during growth, sinking from 8 to 4 % of the length of the body or from about 33 to 13 % of the length of the head, while the fish grows from 5 to 73 cm. Their position is such that the straight line from the tip of the snout to the upper point of the gill-cover touches the inferior margin of the pupil, and the length of the snout is generally about $^3/_4$ of the postorbital length of the head, but in young specimens may measure 80 or 90 % thereof, and in old, on the other hand, sometimes only $^2/_3$. The breadth of the interorbital space, which also undergoes relative diminution, though not so considerable, measures about $^1/_4$ (usually 22—25 %) of the length of the head. The nostrils, with their slightly raised, lobate margins, lie nearer to the eyes than to the tip of the snout. The mouth is large, but not much cleft, the corner of the mouth lying at least at some distance in front of the eye; and the upper jaw projects more or less beyond the lower. As in most of the Codfishes, the transverse dermal folds in the mouth behind the jaws are wanting. The length of the lower jaw follows the head in its changes of growth, varying between about $12^1/_2$ and $15^1/_2$ %[c] of the length of the body. The hind extremities of the maxillary bones are broad and truncate, their breadth at this point being about 18—20 % of the length of the lower jaw. The distance between the tip of the snout and this point also increases with the head, varying between 11 and 14 %[d] of the length of the body or 80 and 92 % of the length of the lower jaw. The snout is formed by a thick pad, projecting beyond the upper jaw, and in old specimens is generally blunt, in younger ones more pointed. We find an exception to this in very young fish, under 50 mm. in length, in whose case the upper jaw projects only slightly, if at all, in front of the lower. Under the point of the chin there hangs a barbel, generally wavy, and varying in length between about 50 and 80 % of the longitudinal diameter of the eye. On the intermaxillary bones, as well as in the lower jaw, we find pointed, subulate teeth of various sizes, in the lower jaw set in two or three rows, and on the intermaxillary bones in patches, which in front are broad and separated from each other. The teeth are largest in the outermost row in the upper jaw, and the innermost row in the lower, being here recurved and increasing in size towards the corners of the mouth, though the hindmost ones are somewhat smaller. In young specimens, however, only the row of coarser teeth in the lower jaw is visible, the smaller teeth that lie in front of this row appearing later. Similar, cardiform teeth are set on the anterior, angular part of the vomer. The pharyngeals are also armed in the same way. Of the three upper pharyngeals on each side the middle ones are the largest and triangular in shape, the other two more elongated. The two lower pharyngeals are rather like branchial arches and elongated, the lancet-shaped patch of teeth being about four times as long as it is broad. The branchial arches are furnished as usual with two rows

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so far as one could decide — seemed to have belonged to a Common Cod about 12 dcm. long. That the Cod has attained such a size off Gothland, is very improbable; and as it is the greater number of just those bones which are left behind in the curing of stockfish, and no others, that still remain in the *Doomsday Fish*, the suspicion readily suggests itself that the fish has been a large stockfish, brought by some Gothland seaman from Norway, and deposited in the church, where in olden times everything remarkable and rare was preserved.

[a] We must here remark that our measurements of this species only comprise specimens up to a length of about $7^1/_2$ dm.

[b] In the so-called *Gadus macrocephalus* the length of the head is said even to exceed $^2/_5$ of that of the body.

[c] In *G. macrocephalus* sometimes at least as much as 18 %.

[d] In *G. macrocephalus* sometimes at least as much as $16^1/_2$ %.

of gill-rakers, the anterior (outer) row on the first arch containing long, pectinate spines, the other spines short and denticulated. The branchiostegal membrane is furnished with 7 rays, is deeply incised and continuous under the isthmus, without being attached at the margin to the latter. The margins of the gill-covers are surrounded by a narrow rim, and the operculum, which is comparatively small and triangular, is deeply notched on the hind inferior side, thus projecting in a point both above (behind) and below.

The body is covered with fine, thin, and imbricated scales, which, though here of smaller size, also clothe the head and the bases of most of the fins, especially the caudal. The lateral line is broad, but narrower in front, and lies much nearer to the back than to the belly, highest below the first dorsal fin and straight from the middle or end of the first anal fin to the caudal fin. It has a chain-like or articulated appearance, as though it were composed of low, oblong projections. The anal aperture lies below the beginning of the second dorsal fin, in young specimens somewhat in front of, in old somewhat behind, the middle of the body, the distance between it and the tip of the snout varying between about 42 and 52 % of the length of the body.

The first of the three dorsal fins is the highest, with rounded apex, and begins somewhat behind the perpendicular from the upper angle of the pectoral fin, at a distance from the tip of the snout that measures about 30—33 %[a] of the length of the body. It contains from 12 to 15 rays, the first two simple, the rest, with the exception of the last or the last two, branched, the third, fourth, or fifth the longest, measuring about 12—14 %[b] of the length of the body. The length of its base is about $10^{1}/_{2}$—$13^{1}/_{2}$ % of that of the body. The second dorsal fin, varying in length between 17[c] and 20 %, and in height between 12 and 9 %, of the length of the body, in old Cod is about twice as long as high, in younger ones comparatively longer. It begins at a distance from the tip of the snout equal to about 43—47 %[d] of the length of the body, is highest in front, with the upper margin even and sloping backwards, and is made up of 16—20 rays, the first two, and sometimes the first four, as well as in most cases the last two, simple, the others branched, and the third, fourth or fifth the longest. The third dorsal fin begins at a distance from the tip of the snout that measures 62—68 % of the length of the body. In height and shape it resembles the second, but is shorter, its length varying between about $16^{1}/_{2}$ and 13 % of that of the body. It generally contains 17—19 rays, the first three rays and sometimes the last ray simple, the others branched at the tip. In this fin too, the third, fourth, or fifth ray is the longest.

The two anal fins are analogous to the two posterior dorsal fins in shape and position, though in young specimens less than about 100 mm. long, the distance between the first anal fin and the tip of the snout is somewhat less than that between the second dorsal fin and the same point, but in older specimens increases more and more even in this relation, the latter distance sometimes sinking at least to 86 % of the former. The first anal fin, the length of which measures about 20—$17^{1}/_{2}$ % of that of the body, generally contains 19 rays, the first two, three, or four, as well as in many cases the last ray, simple, the rest branched at the tip, and the sixth ray the longest, measuring $10^{1}/_{2}$—12 % of the length of the body. The second anal fin varies in length between about $15^{1}/_{2}$ and $12^{1}/_{2}$ % of the length of the body, and is generally composed of 17 or 18 rays, similar in structure to those of the preceding fin, the third ray being the longest, and measuring 10—8 % of the length of the body.

The caudal fin is truncate, with 24 or 26 (sometimes 23 or 27) divided rays; and the length of the middle rays varies between 7 and 9 % of that of the body.

The pectoral and ventral fins are about equal in length in young and middle-sized Cod, while in old specimens the latter are somewhat shorter than the former. The pectoral fins are rounded at the tip. Their length varies between 15 and $12^{1}/_{2}$ % of that of the body. They usually contain 19 or 20 rays, the first more than half as long as the second and, like the latter, simple, the third and fourth the longest and, like the rest, branched at the tip. The ventral fins are set in front of the pectoral, their tips extending to the middle of the latter, when depressed along the body. They contain 6 rays, the second ending in a long, filamentous tip.

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[a] In *Gadus macrocephalus* up to at least 38 %.

[b] In *G. macrocephalus* up to at least 15 %.

[c] Exceptionally 16.

[d] Exceptionally 42, in *Gadus macrocephalus* at least 51.

The cavity of the abdomen extends back to a line with the 6th—9th rays in the first anal fin, or about half-way along the body behind the eyes, or almost twice the length of the head from the tip of the snout. To this point in the hind part of the bottom of the cavity the left lobe of the liver extends on the left side, and on the right side the posterior part of the intestinal coil, which is double only in front. The intestine runs upwards from the pylorus, with its numerous appendages[a], under the anterior part of the stomach to the right, above the rounded middle lobe of the liver, where it curves backwards, and then runs straight to the end of the abdominal cavity and forward to the anterior corner of the latter, in about a line with the insertion of the pectoral fins. At this point it again bends sharply backwards, to the right of the stomach and finally under this organ, to the anal aperture, which has the bottom of the stomach just in front of it. Between the first bend of the intestine and the anterior part of the stomach lies the gall-bladder, and behind the latter, between the coil of the intestine and the hind part of the stomach, the spleen. Both are oblong, the former with rounded ends, the latter more pointed at the extremities. In a female 445 mm. long we find the length of the gall-bladder to be 25 mm., and of the spleen 24 mm.; in a male 453 mm. long the length of the former is 24 mm., and of the latter 34 mm. The ovaries of the females ("*byxorna*" [breeches] as they are called by the fishermen) together form an X-shaped cross, with the tumid point of union situated in the anal region, and the anterior ends considerably elongated during the spawning-season. The testes of the males ("*kruset*" [crape]) are long and lobate at the spawning-season, like bands arranged in folds as in a frill. The air-bladder is white, but like the mother-of-pearl peritoneum, covered with black pigment, and has its thin roof firmly attached to the transverse processes of the spine almost throughout the length of the abdominal cavity. Its broad, convex, anterior end lies just behind the diaphragm, and sends out on each side a tubular process which runs forward to the diaphragm and rises like a vermiform blind sac by the side of the anterior portion of the kidney. The urinary bladder is fairly large and saccate, and is furnished on each side, or on only one side of the urethra with a smaller, but also saccate, secondary bladder. It opens in common with the sexual organs behind the vent, in the females just in front of a little, conical papilla, and in the males at the point of a similar papilla.

Hermaphrodites of the Cod are sometimes met with. J. A. Smith describes two[b], the first with both ovaries fully developed, the second with the left ovary larger than the right. In both specimens the testes were developed in front of and beside the right ovary, united by ligaments to the latter, and, in part at least, with tubular canals opening into it.

The colour of this species is highly variable; but the general coloration, which applies to almost all the varieties, is as follows. The upper parts of the body are in general dark ash-gray or olive-gray, with dense, yellow or brownish, round spots, which are wanting on the anterior part of the head and more scattered down the sides. The lower parts of the body are whitish, without spots. All the vertical fins are gray, with more or less distinct, dark spots, which sometimes form transverse bands. The pectoral and ventral fins are lighter and plain, the latter being often of the same colour as the belly. In old and large Cod the iris is silvery, in younger ones yellowish, and in the dark olive-green or red variety more or less reddish.

The different colour-varieties — due to the different phases of light and colour in different localities, to the different nature of the bottom or of their food — have received separate names, and may be distributed among three groups:

1. The Great Cod (*Stortorsk*) or *Skrej* (Pl. XXIII, fig. 1) also called *Kabiljo*[c], *Vålgild torsk*, and, when young, Small Cod (*Småtorsk*) with clayey ground-colour, gray or blackish, with dark grayish brown or blackish spots above and lighter, brown or yellow spots at and below the lateral line.
2. The Grass Cod (*Gråstorsk*, Pl. XXII, fig. 2), olive or greenish gray, thickly strewn with grayish brown or brownish spots. When this variety

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[a] Kröyer counted 207 pyloric appendages, all closely united by connective tissue into larger and smaller bunches.

[b] Journ. of Anat. and Phys., vol. IV (1869—70) p. 256.

[c] *Kabiljo* (*Kabeljauw*) or *Backeljo* (*Backeljaune*) is an old Dutch name for the Cod, which is perhaps connected with the Latin *baculum*. Cf. *bacchus*, above. Another ancient name of the Cod is the Dutch *dogge*, which is the origin of the name of the Dogger Bank in the North Sea.

is more than usually dark, as often occurs in the Baltic, it is called Black Cod (*Scarttorsk*).

3. The Rock Cod (*Bergtorsk*) or Red Cod (*Rödtorsk*) (Pl. XXII, fig. 3), the Norwegian 'Tang Cod' (*Taretorsk*), red, with dense, fine spots and red fins, or with grayish brown fins and back, and red iris.

The Cod is one of the most common fishes in the north of the Atlantic, at least about 300,000,000 or 400,000,000 being taken annually in this ocean, and it is also of frequent occurrence in the north of the Pacific, though it has not yet been ascertained whether the range of the species is equally extensive there[a]. In the Atlantic the species goes south from Spitzbergen and Greenland, on the east side to the Bay of Biscay, and on the west to Cape Hatteras. On the Scandinavian coast it is common both to the west and in the Baltic, where it penetrates, as we have mentioned above, into the Gulfs of Bothnia and Finland, though according to Mela it is extremely rare in their inmost parts[b]. According to Brown-Goode it prefers water of an average temperature of from 35° to 42° Fahr. (+ $1^2/_3$° to + $5^1/_2$° Cels.), and according to Juel[c] the limits of the variations of the temperature of the water in which the Cod will thrive, may be fixed between at least + 2° and + 7° Cels. The species is most plentiful and attains its maximum size on the brinks of the great ocean-depths, to judge by the largest catches, which are made off Newfoundland and the Lofoden Is. We have no complete statistical reports of the Cod-fishery in the Baltic, but its annual value in each Swedish province cannot be more than 10,000 crowns (£550). In Halland the annual value of the Cod-fishery is about 40,000 crowns (£2,200). In Bohuslän the statistics are more complete, and give an annual value of about 650,000—680,000 crowns (£35,750—£37,400). In 1888, on the coasts of Great Britain and Ireland, 729,217 cwt. of Cod were taken, of a value of £339,090[d]. The average yearly catch in Norway, for the years 1866—81, was about $15^1/_2$ million fish of a value of about 13 million crowns (£715,000). The annual catch on the coast of Labrador, Newfoundland, Canada, and the United States is estimated by Hind at 162,500,000 fish.

The Cod likes deep water, and comes into the shallows, in about 15—30 fathoms of water, only during the spawning-season and while it is young. The largest specimens are always found in very deep water, as much as 100 fathoms or even more in depth. Some of the larger specimens, however, repair in late autumn, in November, to rocky and precipitous coasts, apparently to feast on crabs and small fishes before retiring to their winter-quarters. From the deep water where it passes the winter, the Cod ascends in order to spawn very early in the year in the east of the Atlantic, in January and February on the seaward side of the island-belts and in northern regions, generally later further in among the islands, where most of the spawning fish are small, and in the Baltic. In the island-belt of Bohuslän the spawning-season rarely begins before May, earlier or later according to the early or late arrival of the spring. This is also the case in the Scotch firths, according to Parnell; and off Gothland, according to Lindström, the Cod spawns in April. Probably, however, the spawning-season is of lengthy duration, for all Cod do not spawn simultaneously — the older generally spawn earlier than the younger — and each Cod requires several weeks — according to Earll sometimes two months — to deposit its spawn, as the whole roe does not ripen at once, but only partially and gradually. The eggs are extremely numerous, though their number varies with the size of the fish. In a female 3 ft. 3 in. long and 21 lbs. in weight Earll estimated the number of the eggs at 2,732,237, and in another 75 lbs. in weight, whose ovaries weighed 8 lbs. 8 oz., at 9,100,000. Earll assumes that only about $^1/_4$ of these eggs could grow ripe for depositing each week during the spawning-season. During his investigations of the Cod-fishery off Cape Ann (Mass.) in 1878—79, he found the first spawning female on the 2nd of September, and at the beginning of December half the specimens taken were in spawning condition. In this locality, too, the spawning was at its height in February and March, but even on the 10th of May half the females caught had not finished spawning, and in June, when the fish deserted the coast, a few females, though with ripe roe, had not yet quite emptied their ovaries. The size as well as the number of the eggs varies with the size of the fish. In Cod $2^{1}/_{4}$—$3^{2}/_{3}$ kgm. in weight EARLL found eggs which after impregnation were 2·8 mm. in diameter, while in other females, $11^{1}/_{3}$ kgm. in weight, the impregnated ova measured 3·2—3·6 mm.

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[a] Of the fishery on the coast of Alaska Bean writes (*Cat. Coll. Fish. U. S. Nat. Mus.*, Gt. Intern. Fish. Exhib. London 1883, p. 6): "The most important species, commercially, is the Common Cod (*Gadus morrhua*), which is exceedingly plentiful on certain banks in the Gulf of Alaska and in the vicinity of the islands of the Aleutian chain. This fish will some day be as valuable in the Pacific as it is now in the Atlantic." The range of the Cod also extends, according to Bean (Fish. Comm. Rep. 1882, p. 1039), from Puget Sound north to the Arctic boundary of Behring Sea and west to Okhotsk.

[b] According to Grimm (*Fishing and Hunting on Russian Waters*, p. 11) the Cod goes quite up to Kronstadt.

[c] Norsk Fiskeritidende, 8:de Aarg. (1889), p. 301.

[d] Fish Trades Gazette, 12th and 26th Jan., 1889.

During the spawning season the females keep near the bottom, the males probably joining them there, but seeming generally to swim higher in the water. The greatest number of breeding females, according to EARLL, are caught on long-lines with the bait lying on the ground, while the males are taken at this season on long-lines and hand-lines with the bait held free, away from the bottom. The roe is also fertilized while floating in the water, and rises higher and higher towards the surface, where the first stages of the development are passed. This discovery was made by SARS in 1864, and has subsequently given rise to many other similar observations. When the young fish leaves the egg, it still retains the original (fœtal) curvature of the body, says EARLL, but it soon straightens out, and is then about five-sixteenths of an inch in length, with large, but highly transparent yolk-sac, which is absorbed in from 10 to 15 days. The fry now seek shelter under *Medusæ* and other floating objects, with which it drifts about and approaches land. During the course of the summer Cod-fry are found in shoals at the surface of inlets and channels. The growth is rapid, but as usual irregular, these shoals consisting of young specimens of very different sizes. EARLL estimates the average growth as follows:

Cod fry	$2^{1}/_{2}$—3 in.	(38—76 mm.)	in length	are	$^{1}/_{2}$ year old		
,,	10—11 ,,	(254—279 ,,)	,,	,,	,, $1^{1}/_{2}$ years ,,	and weigh	7—8 oz.
,,	17—18 ,,	(432—457 ,,)	,,	,,	,, $2^{1}/_{2}$,,	,, ,,	2—$2^{1}/_{4}$ lbs.
,,	22 ,,	(559 ,,)	,,	,,	,, $3^{1}/_{2}$,,	,, ,, ,,	4—5 ,,

In autumn, according to SARS, when they have attained a length of about 1 dm., the fry begin to descend to the bottom in some fathoms of water, and in November and December he found young specimens, between $15^{1}/_{2}$ and $18^{1}/_{3}$ cm. long, at a depth of 8—12 fathoms, generally on the edge of deep water. At midsummer he took Cod at a depth of 100—150 fathoms between 20 and 30 Norwegian miles off shore.

The smallest ripe male EARLL met with, weighed $3^{1}/_{2}$ lbs. (about $1^{1}/_{2}$ kgm.), and the smallest ripe female 5 lbs. ($2^{1}/_{4}$ kgm.) Hence he concludes that the males are ripe in their third year, the females not until their fourth. After this period they seem to spawn regularly every year, for at the beginning of the fishing-season he did not meet with a single adult Cod whose sexual organs showed any sign of sterility.

The Cod is one of the most voracious fishes. Its food is probably composed strictly of small fishes, crustaceans, and worms, but in its fierce hunger, especially after the spawning-season, it swallows everything that attracts its attention in the least. Even stones are sometimes found in its stomach, and the fishermen then say that the Cod has taken in ballast to sink into deep water. The probable explanation of this, however, as KRØYER has already suggested, is that the stones have been swallowed, not for their own sake, but for that of the small marine animals with which they have been covered. In temperament the Cod seems to be very sluggish, and its movements in the water are anything but active. Most methods of catching it are, therefore, based on its voracity. In deep water it is generally taken on hand-lines (*handsnöre* or *storsnöre*) or long-lines (*linor* or *backor*). The *hand-line* is a strong, three-stranded cord, about 170 or 180 m. long, with a somewhat finer snood, 1 metre long, to which are attached the hook and a heavy plummet of lead. The *long-line* is a three-stranded, tarred line, about 5 cm. in circumference and about 225 m. in length. To a line of this size 50 hooks are attached, each with a snood a metre and a half long, and all the snoods, with the exception of every fifth one, are furnished with a float to keep the hook and bait from the bottom. On the snoods that have no float, Skate are taken. Each fishing-boat that sails from Bohuslän in spring, takes with it 30 or 40 of these long-lines to the fishing-banks west of Jutland and Norway. Within the island-belt of Bohuslän the Cod is taken with the *sladörj*, a finer hand-line, generally made of horsehair and with two hooks. A bait of mussels, or, still better, of pieces of fish, especially fresh Herring and Mackerel, is used. Another method of taking Cod, less common in Sweden, but more so in Norway[a], is with gill-nets, both at the spawning-places and in the fjords, sometimes in 50—90 fathoms of water. These nets have meshes 86—93 mm. square, and are from 15 to 20 meshes deep. They are shot partly along the bottom (*botten*-garn, bundgarn at Lofoden) and partly nearer the surface (*flytgarn*, *flöit*-garn at Lofoden floating nets).

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[a] Cf. also COLLINS, Bull. U. S. Fish. Commission 1881, p. 1.

The flesh of the Cod is firm, white, and of good flavour, best when fresh, but only a very small proportion is consumed in this form. It is generally salted, and appears in the market under the name of *Haberdine* or *Laberdan* (*Kabiljo*). The curing takes place, briefly, as follows: Immediately after the capture of the fish it is killed by a deep slit across the throat (isthmus), so that the blood may drain away. Then it is opened along the belly, the head is cut off, and the backbone removed to the third vertebra behind the vent; the dark peritoneum and the entrails should also be removed at the same time. Finally it is washed, and laid on twigs or in baskets for the water to run off. The actual salting takes place, as soon as possible, either on board the vessel or in the factory on shore. It is performed in one of two ways: in bins or layers, when it is called *dry-salting*, or in watertight casks, when it is called *pickling*.

When the fish are salted on shipboard, a bottom layer of salt is laid for the purpose in chests or bins. In these the fish are arranged, well strewn with and imbedded in salt, with the broad end downwards and the tail upwards, though not quite straight up and down, in rows across the bin, until the whole bottom layer is full and compact. Then enough salt is strewn on the top to cover the tails almost entirely. The other layers, which are arranged one above another, are prepared in the same way.

In from 5 to 10 days, according to the warmth or coldness of the weather, the fish has absorbed the necessary amount of salt. It is then taken out of the bin, dried in the open air, and laid in a stack, with weights upon it, to be pressed. It is then ready for use.

Dry-salting on land is performed in the same manner. The most important point to be observed, if an article that will bear keeping is required, is that the fish shall be laid out to dry in such a position that the wind may have free passage above and below it. The spot chosen should be shady, but free from damp.

Pickling is carried out in watertight casks. The fish is killed and cleaned as in the process of dry-salting, and then salted in casks, the split fish being placed in a layer on the flat side, inside to inside and outside to outside, with enough salt between the layers to prevent one layer from touching the next. In from 5 to 8 days the fish is sufficiently salted. It is then taken out of the cask and laid in a stack, that the brine may drain away, before it is dried and pressed as described above.

When the salt fish is discharged from the vessel, it should be rinsed in fresh brine and pressed in heaps, the tails being always turned outwards. In a few days it should be taken out of the press and dried in a breezy spot, but not in the sunshine.

The most necessary condition is that the fish shall be bled and entirely cleaned as soon as possible; and a good salt article can be manufactured only of fresh fish, not more than a day or two after its capture.

(Ekström, Smitt.)

The Arctic seas possess three Cod-species, each of which has its interest in the Scandinavian fauna, though none of them has yet been found within its limits.

The nearest approach to our Common Cod we find in the species which Fabricius[a] described from Greenland under the name of *Gadus barbatus*, and which the Esquimaux call *ogak*, *ovak*, or *ouak* (Pl. XXII, *A*, fig. 1: *Gadus ogac*, ♂, $^1/_2$ of the natural size; Claushavn, Dr. P. Öberg). Fabricius, according to the Linnæan method described above, distinguished between the Cod (*Gadus callarias*) and the *Kabiljo* (*Gadus morrhua*) on the coast of Greenland, and also thought that in the Linnæan name of *Gadus barbatus*, which really belongs to the Bib, though Linnæus also applied it to the Common Cod, he had a suitable title for the Esquimaux *ogak*. Richardson[b] saw the fault in the name and changed it to *Gadus ogac*, which Reinhardt[c] soon afterwards wrote *Gadus ovak*, while Kroyer[d], probably by a slip of the pen, changed it to *Gadus ogat.* So close is the connexion between this species and *Gadus callarias* that most recent writers have identified it with the latter. Dressel[a], however, refers us to his measurements of four specimens of *G. ogac* and the same number of *G. callarias*, and gives the following specific characters: in *G. ogac* the peduncle of the tail is shallower, the eyes and the interorbital space larger, the barbel longer, the ventral fins set farther forward, and the pectoral fins longer, than in *G. callarias.*

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[a] *Fauna Groenlandica*, p. 146.

[b] *Fauna Boreali-Americana*, *Fishes*, p. 246.

[c] D. Vid. Selsk. Naturv. og Matem. Afh., Deel 7, p. 127, No. 35.

[d] Gaim., *Voy. en Scandinavie et Laponie*, pl. 19.

The Dicksonian expeditions to Greenland have put the Royal Museum in possession of four specimens of *Gadus ogac*, between 294 and 566 mm. long, which show that most of the characters given by Dressel lose their validity when compared with the numerous changes of growth in *Gadus callarias.* One of these characters, however, that which is drawn from the relative breadth of the interorbital space, and is adopted in our table for the distinction of the species within this genus, has proved universally true. This character, as well as the difference that appears in the average position of the ventral fins, is of great interest in our fauna, for, though the Baltic Cod never attains quite the same point as *ogac* in this respect, still it comes much nearer the latter, on an average, than the oceanic Cod does.

In the Cod the breadth of the interorbital space increases even relatively during growth, rising in proportion to the length of the body, according to our measurements of Cod from the Cattegat and Skager Rack, from 5·9 % in specimens on an average 142 mm. long to 6·9 % in specimens on an average 462 mm. long. In the Baltic Cod that we have measured, the latter percentage appears in specimens of an average length of 422 mm., and in our specimens of *G. ogac*, of an average length of 435 mm., this proportion is on an average 8·4 %. In this relation, however, the character is not constant, for in macrocephalic Cod the percentage may rise to at least 9; but it becomes constant if we compare the breadth of the interorbital space with the length of the head, when we obtain the following average results:

	Average length of the body in mm.	Average least breadth of the interorbital space in % of the length of the head.
In Cod from the Cattegat and Skager Rack	101.5	21.8
,, ,, ,, ,, ,, ,, ,, ,,	203.5	22.4
,, ,, ,, ,, ,, ,, ,, ,,	265.5	22.9
,, ,, ,, ,, ,, ,, ,, ,,	461.6	23.3
,, ,, ,, ,, Baltic ,, ,, ,,	422.0	24.6
,, *Gadus ogac*	434.5	30.1

In accordance with the general rule for the changes of growth of the Teleosts, that the ventral fins move more and more forward, the distance between the foremost (outermost) point of the insertions of these fins and the beginning of the first anal fin shows a persistent increase during growth in the Cods, when compared with the length of the body. The length of the base of the first anal fin also persistently decreases in comparison with the distance between this fin and the ventral fins. In these respects too, *Gadus ogac* is most advanced in development, though the Baltic Cod show a distinct tendency towards the same point.

	Average length of the body in mm.	Average distance between the insertions of the ventral fins and the beginning of the first anal fin in % of the length of the body.	Average length of the base of the first anal fin in % of the distance from the insertions of the ventral fins to the beginning of the first anal fin.
In Cod from the Cattegat and Skager Rack	89.4	19.2	93.9
,, ,, ,, ,, ,, ,, ,, ,,	192.0	21.2	91.1
,, ,, ,, ,, ,, ,, ,, ,,	468.3	24.1	74.8
,, ,, ,, ,, Baltic ,, ,, ,,	422.0	26.1	74.2
,, *Gadus ogac*	434.5	29.7	62.3

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[a] Proc. U. S. Nat. Mus., vol. VII, p. 246.

As we are still ignorant of the changes of development of *Gadus ogac* in its younger stages, we must indeed confess the possibility that the limits of the variations may cross even in the character derived from the breadth of the interorbital space; and in this case *Gadus ogac* must be regarded simply as a form-variety of the same species as the Common Cod. In whatever way this point may be decided by a more complete investigation of *G. ogac*, it is quite certain that this form comes so near the Common Cod in its entire structure that these two forms must have had a common origin at no distant period. To judge by the tendency of the changes of growth, *Gadus callarias* is less removed from this origin, and *G. ogac* seems to be a more purely Arctic branch of this stock. The theory propounded by S. LOVÉN to explain the peculiarities of the Baltic fauna, with its numerous connexions with Arctic forms, on the hypothesis that there anciently existed an immediate communication between the waters where these two faunæ now live apart, finds another support here: a form of *G. ogac* may once have inhabited the Baltic, though its characters, if this be true, have grown more indistinct, while they have been persistent in the Arctic Ocean itself, on the coast of Greenland[a].

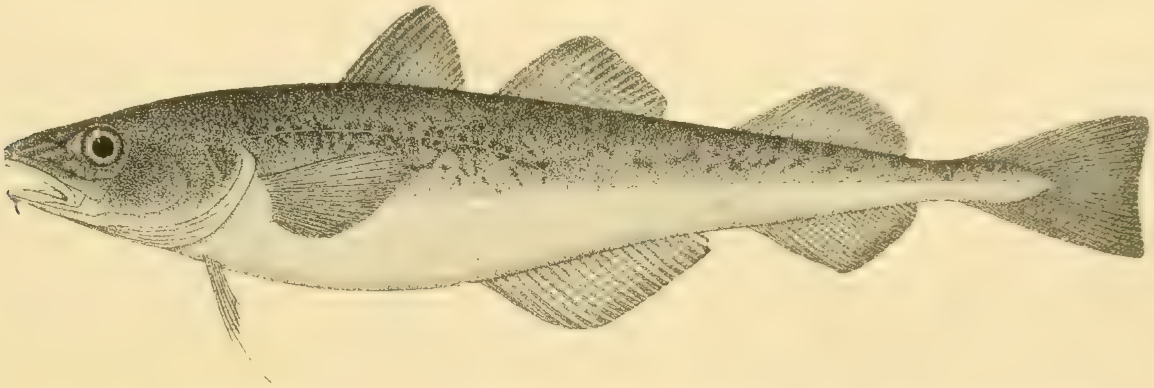

Fig. 119. *Gadus navaga*, ♂, $^2/_3$ of the natural size. Archangel. 1878: Lieut. H. SANDEBERG.

The other two Arctic species — or probably varieties of the same species — which come remarkably near the Cod, are the Russian *navaga* or *novaga*, as it has sometimes been called, (fig. 119) and *wachnja*[b] (Plate XXII, A, fig. 3: *Gadus gracilis*, $^1/_2$ the natural size. Pitlekaj, 21st Oct., 1878; Vega Expedition). The former[c] has long been known in Russia, where it is caught in large quantities in the White Sea, and conveyed in winter, in a frozen condition, to St. Petersburg and Moscow, where it ranks as a delicacy. The latter[d], on the other hand, was stigmatized by STELLER as neither of good flavour nor nourishing, being therefore thrown to the dogs. TURNER gives *wachnja* the same character; and it was long rejected by the crew of the *Vega*, according to NORDENSKIÖLD, on account of the grayish green colour of the bones. Both are distinguished from the Cod by the comparatively smaller size of the head and more elongated form of the body; and both are remarkable for the singular lateral processes from the air-bladder, which fit into the above-mentioned cavities in the transverse processes of most of the posterior abdominal vertebræ[e]. On this ground FISCHER proposed to establish the genus *Eleginus*, while Bean proposed for the same reason[a] to restore Swainson's genus *Tilesia.* But the singularity in point is only a more advanced development of the connexion between the air-bladder and these transverse processes that occurs in other species of the genus *Gadus.* The two vermiform processes, from the front of the air-bladder, which we have just described in the Common Cod, occur in exactly the same form here; and a remnant of the pneumatic duct may occur in some specimens, as in the case of the Common Cod, though I have sometimes failed to find a trace of it.

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[a] The fin-formula in *Gadus ogac* according to our investigations is: *D.* 14—15/19—20/18—20; *A.* 20—23/18—19; *P.* 18—19; *V.* 6; *C.* $x+20-25+x$.

[b] The name of *wachnja*, according to STELLER, is a Russian corruption of the Kamchatkan *wakal*. According to NORDQVIST (Vega-exp. Vet. Iaktt., 1:sta Bd. p. 396) the Chukchees call the Cod *urokadlin* and the Polar Cod (*saida*) *uakan*. The Esquimaux, according to Captain JAKOBSEN, pronounce *ogak* almost as *ooak*. The root of all these words seems to be the same.

[c] KÖLREUTER (Nov. Comment. Acad. Sc. Petrop., vol. XIV, tom. I (1770), p. 484, tab. XII) is generally quoted as the inventor of the specific name of *Gadus navaga*, though, like TILESIUS (Mém. Acad. Pétersb. tom. II (1810), p. 352), he expressly identifies *navaga* with LINNÆUS's *G. callarias*. LEPECHIN declared the form to be a distinct species (Nov. Comm. Petrop., tom. XVIII (1773), p. 512, not.), but gave it no systematic name. PALLAS (*Zool. Rosso-Asiat.*, III, p. 196) was the first to give it a full binomial designation.

[d] *Gadus gracilis*, TIL., l. c., p. 354, tab. XVIII, XIX, XX; JORD., GILB., Bull. U. S. Nat. Mus., No. 16, p. 804. *Gadus wachna*, PALL., l. c., p. 182. *Gadus navaga*, NORDENSKI., *Vegas färd kring Asien och Europa*, 1:sta delen, p. 465; SMITT, Gt. Intern. Fish. Exh. London 1883, *Swed. Cat.*, p. 176. *Tilesia gracilis*, TURNER, *Nat. Hist. Alaska*, p. 90, pl. 3.

[e] Cf. FISCHER, Mém. Soc. Natural. Moscou, tom. IV (1812—13, réimprimés en 1830) pp. 257 et 259, tab. VII, figg. 2—4; BAËR, Bull. Scient. Acad. Sc. Petersb., tom. III, p. 359.

These two forms are so closely connected that the relationship between them must be regarded as even more intimate than that between *Gadus callarias* and *G. ogac;* and the only constant distinction between them that has hitherto been suggested, is derived from the coloration — in *navaga* the dorsal side, above the transverse processes, which are externally perceptible to the touch, is grayish green with darker, brown spots, reminding us of the common Baltic Cod, while in *wachnja* the dorsal side is plain yellow or reddish gray[b]; but the ventral side in both forms is silvery white, finely punctated with blackish brown. Their habitats, however, are distinct, as far as we can decide from our present acquaintance with them; and even if the above character is the only valid one, they must, therefore, be regarded at least as distinct local varieties. *G. navaga* lives in the immediate neighbourhood of the Scandinavian fauna, from the Murman coast and the White Sea at least as far east as the River Obi. *G. gracilis* was first discovered by Steller and Tilesius in Kamchatka Sea, and, according to Pallas, is known by the Japanese as *tara.* Nordenskiöld bought it in quantities of the Chukchees at *Pitlekaj;* and we have a description by Turner, from Alaska, as well as a drawing from Nordenskiöld's winter-quarters, of the manner in which the Chukchees and Esquimaux catch this species during their winter-fishing in holes made in the ice[c]. How far west *wachnja* goes, or how far east *navaga,* is a point on which we have no further information. If the forms are really distinct in their geographical range, they give us an excellent example of systematic separation in spite of the closest kinship, an example which is given as briefly as possible in the appended tables. First we give a table of averages of the most important external relations in four specimens of *navaga,* varying between 171 and 240 mm. in length, and three of *wachnja,* between 345 and 382 mm. long.

Average in		4 specimens of *navaga* from Archangel.	3 specimens of *wachnja* from Pitlekaj.
Length of the body expressed in millimetres		204	358
,, ,, ,, lower jaw	in % of the length of the body	10.1[d]	9.5[e]
Distance between the tip of the snout and the hind extremity of the maxillary bones	,, ,, ,, ,, ,, ,, ,, ,,	8.8[f]	8.3[g]
Length of the base of the third dorsal fin	,, ,, ,, ,, ,, ,, ,, ,,	15.5[h]	14.7[i]
Greatest depth of the body	,, ,, ,, ,, ,, ,, ,, ,,	13.8[j]	16.9[k]
,, breadth ,, ,, ,,	,, ,, ,, ,, ,, ,, ,, ,,	10.8[l]	12.0[m]
Least depth ,, ,, ,,	,, ,, ,, ,, ,, ,, ,, ,,	3.7[n]	4.3[o]
Length of the head	,, ,, ,, ,, ,, ,, ,, ,,	22.2	22.2
,, ,, ,, ,, behind the eyes	,, ,, ,, ,, ,, ,, ,, ,,	11.1	11.6

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[a] See Jord., Gilb., l. c.

[b] According to Turner the fish is grayish brown above, when fresh; and in some specimens small, dark spots appear on the sides.

[c] In summer, according to Turner, it is taken in Alaska by fishing with long rods from jutting rocks.

[d] Minimum in these specimens = 9·7.

[e] Maximum ,, ,, ,, = 9·5.

[f] Minimum ,, ,, ,, = 8·7.

[g] Maximum ,, ,, ,, = 8·4.

[h] Minimum ,, ,, ,, = 15.2.

[i] Maximum ,, ,, ,, = 15·0.

[j] ,, ,, ,, ,, = 16·2.

[k] Minimum ,, ,, ,, = 16·7.

[l] Maximum ,, ,, ,, = 11·1.

[m] Minimum ,, ,, ,, = 11·3.

[n] Maximum ,, ,, ,, = 3·9.

[o] Minimum ,, ,, ,, = 4·1.

Average in	4 specimens of *navaga* from Archangel.	3 specimens of *wachnja* from Pitlekaj
Longitudinal diameter of the eyes in % of the length of the body	3.5	3.6
Least breadth of the interorbital space ,, ,, ,, ,, ,, ,,	5.7	6.1
Length of the snout ,, ,, ,, ,, ,, ,,	7.7	7.4
Distance between the first dorsal fin and the tip of the snout ,, ,, ,,	29.7	30.6
,, ,, ,, second ,, ,, ,, ,,	42.2	43.3
,, ,, ,, third ,, ,, ,, ,,	64.8	65.2
,, ,, ,, first anal ,, ,, ,, ,,	43.5	43.1
Length of the base of the first dorsal fin ,, ,, ,,	10.0	10.3
,, ,, ,, ,, ,, ,, second ,, ,, ,, ,,	17.2	16.6
,, ,, ,, ,, ,, ,, first anal ,, ,, ,,	19.9	18.7
,, ,, ,, ,, ,, ,, second ,, ,, ,, ,,	14.7	14.5
,, ,, ,, longest ray in the first dorsal fin ,, ,, ,,	10.3	11.0
,, ,, ,, ,, ,, ,, ,, second ,, ,, ,, ,,	9.5	9.6
,, ,, ,, ,, ,, ,, ,, third ,, ,, ,, ,,	9.2	9.1
,, ,, ,, ,, ,, ,, ,, first anal ,, ,, ,,	9.1	9.4
,, ,, ,, ,, ,, ,, ,, second ,, ,, ,, ,,	8.2	8.9
,, ,, ,, pectoral fins ,, ,, ,,	13.1	13.7
,, ,, ,, ventral ,, ,, ,, ,,	11.4	11.4
Distance between the ventral fins and the beginning of the anal fin ,, ,, ,,	25.4	23.6
Length of the middle caudal rays ,, ,, ,,	6.4	6.8

We thus find on an average that in *wachnja* the breadth of the forehead is comparatively greater than in *navaga*, just as it is greater in *Gadus ogac* than in the Common Cod; while, on the other hand, the distance between the ventral fins and the beginning of the anal fin, contrary to the tendency of the changes of development and in contradistinction to the relation between *Gadus ogac* and the Cod, is on an average less in *wachnja* than in *navaga*. Only the first six of the relations given in this table, however, show any constant difference of character. The maximum and minimum proportions also show that these differences, with the exception perhaps of the sixth, are difficult to employ in the limitation of the species. Better results are obtained in the following table, which is also calculated to give an expression for the tendency of the changes of growth. This table is based on an examination of twelve specimens, six of *Gadus navaga*, between 171 and 240 mm. long, and six of *G. gracilis*, between about[a] 208 and 382 mm. in length.

Average in	*Navaga.*		*Wachnja.*	
	3 specimens.	3 specimens.	3 specimens.	3 specimens.
Length of the body expressed in millimetres	192.3	227?	242?	358
,, ,, ,, head ,, ,, ,,	42.8	50.3	53.7	79.6
Length of the snout in % of the length of the head behind the eyes[b]	68.7	70.7	64.8	63.0
Least depth of the tail in % of the length of the lower jaw[c]	35.8	38.7	42.3	43.3
,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, snout[d]	47.6	49.6	56.8	56.9
,, breadth of the interorbital space in % of the length of the snout[e]	75.1	73.7	86.3	82.7
,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, head[f]	25.7	25.5	27.9	27.6

[a] The body is so distorted in the smallest specimens that its length cannot be fixed exactly.

[b] Minimum in *navaga* = 68·2 %, maximum = 72·1 %.
Maximum ,, *wachnja* = 65·5 %, minimum = 61.8 %.

[c] Maximum ,, *navaga* = 39·1 %, minimum = 34·3 %.
Minimum ,, *wachnja* = 41·1 %, maximum = 45·4 %.

[d] Maximum ,, *navaga* = 50 %, minimum = 46·1 %.
Minimum ,, *wachnja* = 52·6 %, maximum = 60 %.

[e] Maximum ,, *navaga* = 78·1 %, minimum = 69·4 %.
Minimum ,, *wachnja* = 80 %, maximum = 88·8 %.

[f] Maximum ,, *navaga* = 26·4 %, minimum = 24 %.
Minimum ,, *wachnja* = 26.7 %, maximum = 28·9 %.

In the first relation, the length of the snout in proportion to the postorbital length of the head, the direction of development differs in the two forms, and thus indicates a true specific distinction. In the other relations the direction of development is the same, but the difference between the percentages in both forms is considerable enough — in *c* and *d* at least — to be employed as a specific distinction. For all this, the forms are so like each other that one may well be tempted, remembering the dubious value in the Cods of the characters drawn from the coloration, to explain *wachnja* as a short-nosed form, which is, however, more advanced in development, of the same species as *navaga*, which is apparently always inferior in size to *wachnja*[a]. The fin-formula may be regarded as identical in both forms, though here, as in several other Gadoid species, we find the peculiarity that in many cases the larger specimens have fewer rays in one or more of the fins[b].

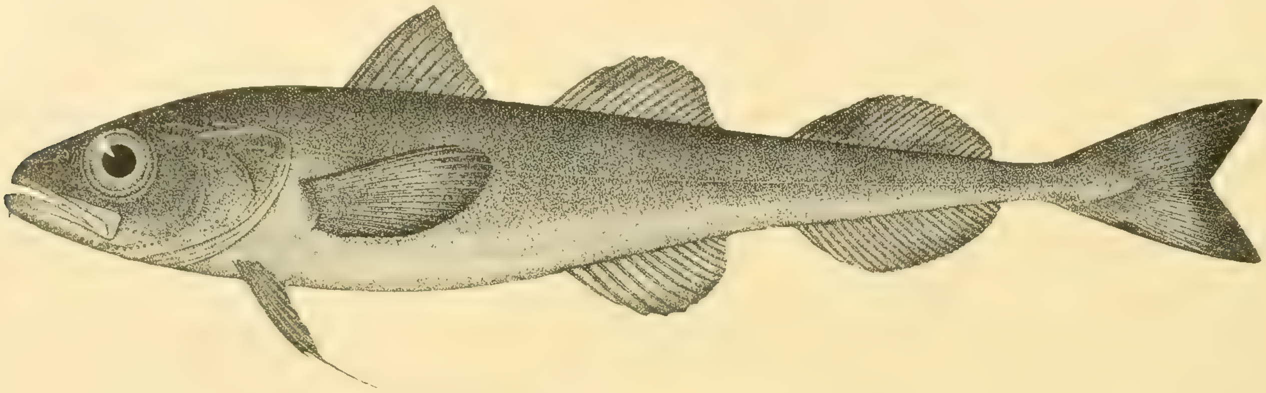

Fig. 120. *Gadus saida*, $\frac{3}{4}$ of the natural size. Archangel Fish Market, 1876; H. SANDEBERG.

Another Arctic species, *Gadus saida*[c], the *Polar Cod* (*Gadus polaris*) of later authors, comes very near *navaga*, but is one of the species that have best claim to the rank of a distinct subgenus[d]. It has never been found alive on the coasts of Scandinavia, but occurs pretty often in our Glacial clays, and has thus at no very distant period, geologically speaking, belonged to the fauna of Sweden and Norway (fig. 121).

The most distinctive characters of the Polar Cod lie in the rapid attenuation of the hind part of the body; the rather forked shape of the caudal fin; the comparatively great distance (as in *Gadus navaga*) between all the vertical fins, the length of the base of the third dorsal fin being at least equal to that of the second dorsal fin; the long paired fins, of which the pectoral fins have the middle rays longest or only slightly shorter than those immediately above them, the great length of the ventral fins being due, as usual, to the filamentous elongation of the second ray; the large eyes; and the prominence (though sometimes only slight) of the lower jaw. Most writers have been induced by the last character to range the Polar Cod next to the Coalfish-group; but the character is present, though only slightly appreciable, in the youngest stages of the Common Cod, and the resemblance between the Polar Cod and *navaga* is too great to admit of any remote separation of these two forms. Again, by the comparatively small number of rays in the first dorsal fin the Polar Cod is incontestably referred to the group of the true Cods[e]. The following table is calculated

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[a] According to PALLAS *navaga* is generally about $7\frac{1}{2}$ in. long (*spithamalis*), *wachnja* 15 in. (*bispithamalis*). The specimen of *navaga* measured by KÖLREUTER was, however, 283 mm. (11·2 in.) long.

[b] *Gadus navaga*: *D.* 13 17 20 21 –24; *A.* 21—24 21—22; *P.* 19—20; *V.* 6; *C.* $x + 25 + x$.
,, *gracilis*: ,, 12—13 16—19 20 –21; ,, 21—23 20—21; ,, 19 ; ,, 6; ,, $x + 23$—$27 + x$.

[c] *Gadus saida*, LEPECHIN, *N. Comm. Acad. Petropol.*, tom. XVIII (1773), p. 512, tab. V; PALL., *Zoogr. R. Asiat.*, tom. III, p. 199; COLL., N. Nordh.-exped., Zool., Fiske, p. 126, pl. IV, fig. 33; BEAN (*Boreogadus*, ex GTHR), Proc. U. S. Nat. Mus., vol. IV (1881), p. 243; JORD., GILB., Bull. U. S. Nat. Mus., No. 16, p. 807; TURNER, *Nat. Hist. Alaska*, p. 89, pl. II; LILLJ. (*Gadus*), *Sv.*, *Norg. Fn.*, *Fisk.*, vol. 2, p. 103. *Gadus aglefinus*, FABR., *Fn. Groenl.*, p. 142. *Merlangus polaris*, SAB., *Suppl. App. Parry's First Voy.*, p. 211; RICHARDS., *Fn. Bor. Amer.*, part. III, p. 247; NILSS., *Skand. Fn.*, *Fisk.*, p. 969; GILL. (*Boreogadus*), Proc. Acad. Nat. Sc., Philad. 1863, p. 233; MGRN, Öfvers. Vet.-Akad. Förh. 1864, p. 531. *Gadus Fabricii*, RICHARDS., l. c., p. 245. *Gadus agilis*, RHDT, D. Vid. Selsk. Math. Naturv. Afh., Deel 7, pp. 115 et 126; NILSS., l. c., p. 568. *Gadus glacialis*, PETERS, *Zw. Deutsche Nordpolarfahrt*, Bd. 2, p. 172.

[d] *Boreogadus*, GTHR, *Cat. Brit. Mus.*, *Fish.*, vol. IV, p. 336.

[e] In *Gadus saida* the fin-formula according to our investigations is: *D.* 12—13 14—18 18—22; *A.* 15 –19 19—22; *P.* 18—19; *V.* 6; *C.* $x + 20$ –$22 + x$.

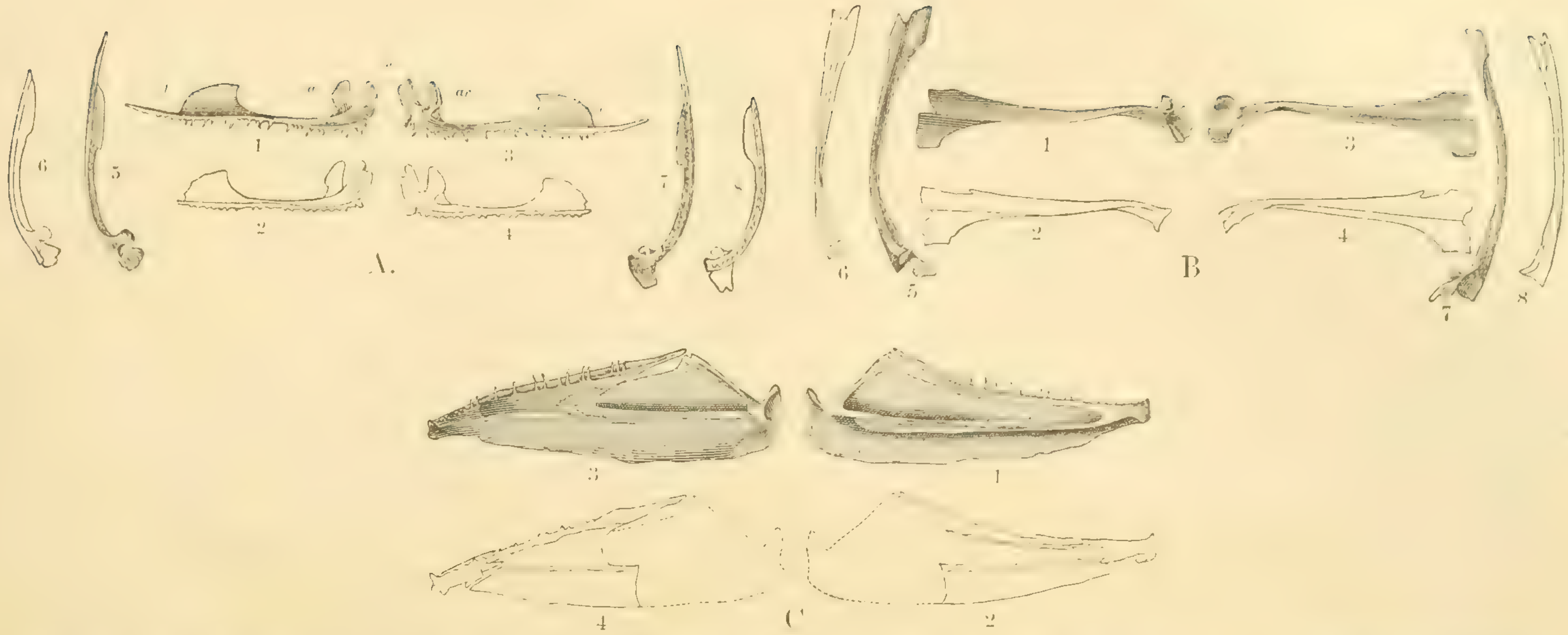

Fig. 121. Comparison between the jaw-bones of a *Gadus saida*, 205 mm. long, from the White Sea (shaded in the figures) and of a specimen of equal size whose remains have been found in the Glacial clay at Lomma, near Lund (drawn in outline). Twice the natural size. Cf. O. Torell. *Undersökningar öfver istiden*. III, Öfvers. Vet.-Akad. Förh. 1887, No. 6, p. 429.
A: right intermaxillary bone, *B:* right maxillary bone, *C:* right branch of the lower jaw.
1 and 2 seen from the outside, 3 and 4 from the inside, 5 and 6 from above, 7 and 8 from below.

very briefly to show the external proportions of the Polar Cod, with especial reference to those corresponding proportions in the case of *navaga* which have just been given.

Average in	*Gadus saida*	
	3 specimens.	4 specimens
Length of the body expressed in millimetres	120	197
Length of the head in % of the length of the body	26.1	24.6
Longitudinal diameter of the eyes	7.2	6.1
Least breadth of the interorbital space	6.4	6.0
Length of the snout	7.4	7.1
Distance between the tip of the snout and the hind extremity of the maxillary bones	11.5	11.3
Length of the lower jaw	13.6	13.1
.. .. .. head behind the eyes	11.6	11.7
Distance between the first dorsal fin and the tip of the snout	30.9	30.0
.. .. .. second	45.[illegible]	45.7
.. .. .. third	64.[illegible]	65.0
.. .. .. first anal	45.7	47.3
Length of the base of the first dorsal fin ,, ,, ,, ,, ,, ,, ,, ,,	11.3	11.5
.. .. second	16.[illegible]	15.4
.. .. third	16.5	15.9
.. .. first anal	16.[illegible]	17.8
.. .. second	17.5	15.4
.. .. .. longest ray of the first dorsal fin	13.5	13.9
.. .. second	12.2	11.3
.. .. third	10.1	9.8
.. .. first anal	10.8	10.0
.. .. second	10.1	8.9
.. .. .. pectoral fins	18.4	18.0
.. .. .. ventral	17.5	17.7
.. .. .. middle rays of the caudal fin	6.4	6.1
Distance between the insertion of the ventral fins and the beginning of the first anal fin ,, ,, ,, ,, ,, ,, ,, ..	22.4	27.1
Greatest depth of the body	16.6	14.7
Least .. .. .. tail	3.2	3.3
Greatest breadth of the body	12.3	10.7

Obs. The first column includes specimens respectively 82, 126, and 153 mm. in length. The length of the specimens in the second column varies between 159 and 216 mm. The earliest stages of development thus do not appear in the table.

Among the other characteristics of the Polar Cod both PETERS and COLLETT have remarked the numerous muciferous pores on the head, which are set in rows, most distinctly in the frontorostral branches of the system of the lateral line, between the eyes and on the snout, in the anterior portion of the suborbital branches, and in the mandibular branches, both on the under jaw and at the hind margin of the preoperculum. The lateral line proper on the body runs fairly straight, at the top of the abdominal region, but descends at the beginning of the first dorsal fin. It is not very distinct, is made up of elongated ducts, and often breaks up, especially on the hind part of the body, into irregularly scattered ducts appearing on the sides of the tail. The scales are small, extremely thin, and not imbricated on any part of the body.

In coloration the Polar Cod is one of the purest and handsomest members of the genus, above light red, on the back itself and the snout brownish, below white or silvery, and everywhere, though most densely on the back, finely punctated with brownish red. The true ventral side alone is sometimes without these small spots. The dark, brownish pigment sometimes collects into nearly black bars and clouds on the vertical fins; and a dark, irregular spot sometimes occurs on the sides, above and behind the insertion of the pectoral fin, though it is apparently very rare, and never so distinctly marked as in the Haddock. The pectoral and ventral fins are also punctated.

The geographical range of the Polar Cod fully justifies its name. PARRY found it amongst the drift ice in lat. $82^3/_4$° N., and it occurs almost everywhere in the strictly Arctic seas round the pole. The least Arctic regions to which it penetrates, are the White Sea, where it lives in company with *navaga*, and Iceland, whence specimens were obtained by STEENSTRUP and described by NILSSON. Off Spitzbergen the Polar Cod has been taken by all the Swedish expeditions in the sledge-net (little trawl) and common dredge, at a depth of from 2 to 30 or 40 fathoms, on a stony bottom, among seaweed or zoophytes. On the 17th of August, 1878, in Magdalena Bay, the Norwegian Arctic Expedition took 72 specimens at a single haul of the trawl in very deep water. At the same time the Vega Expedition met with Polar Cod in 5—10 fathoms of water in Taimyr Sound, and, soon after the expedition had taken up its winter-quarters, off Pitlekaj, the species was also found there. At St. Michaels's (Alaska) TURNER saw the Esquimaux catch Polar Cod by angling at holes in the ice, in about $3^1/_2$ fathoms of water. GÜNTHER[a] mentions a specimen that was taken off Cape Hayes in Grinnell Land. According to FABRICIUS the Polar Cod is fairly common in winter, especially on the north coast of Greenland, along the shore and in the inlets. He states that it may be easily allured to the surface, especially at dusk, by splashing in the water; and that even the Polar fox has learnt this method of catching Polar Cod. In the White Sea this form is often taken together with *navaga;* but its flesh, according to PALLAS, is poorer than that of the latter, and it is, therefore, not sent to St. Petersburg.

The Polar Cod lives principally on fish-ova and small crustaceans, especially *Calani,* and as they very often accompany the drift ice, it follows their example. In this manner it may very probably wander on occasion south of its strict geographical range.

Up to this point none of the Gadoid species that we have described, has been without a barbel under the chin. In *navaga* and *saida* the barbel is indeed small, but is still present. In the type of the following group, the Whiting, the barbel, on the other hand, is generally wanting. This group possesses the prominent snout of the true Cods, but is distinguished from them by the considerably greater length of the base of the first anal fin, which, contrary to the general rule in their case, here seems to undergo even relative increase with age, as appears from the following averages:

Average in	*Gadus merlangus*			*Gadus minutus*	
	3 specimens.	3 specimens.	2 specimens.	3 specimens.	2 specimens.
Length of the body expressed in millimetres	177	359	408	152	207
Length of the base of the first anal fin in % of the length of the body	30.9	32.1	35.9	27.7	29.8

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[a] Account of the Fishes collected by Capt. FIELDEN between 78° and 83 N. lat., during the Arctic Expedition 1875—6 (Proc. Zool. Soc. London 1877, p. 293).

THE WHITING (SW. HVITLINGEN).

GADUS MERLANGUS.

Plate XXIV, fig. 1.

Length of the base of the first anal fin more than half the distance between this fin and the tip of the snout. Upper jaw most prominent. Length of the lower jaw at least about 47 % of that of the head. Least depth of the tail at most about 12 % of the length of the lower jaw. Length of the head at least about 25 % of that of the body. Distance between the tip of the snout and the hind extremity of the maxillary bones more than 84 % of the length of the lower jaw and also greater than the length of the ventral fins. Length of the snout more than 8 % of that of the body, than 75 % of the postorbital length of the head, or than 67 % of the length of the lower jaw. Coloration light, shading into yellow, violet, and green, brownish on the back, milk-white on the ventral sides; lateral line dark; a blackish spot in the upper part of the axil of the pectoral fins.

R. br. 7; *D.* 13—15[1]/20[2]—25/19—22, *A.* 31[3]—38/20—24; *P.* 19—20, *V.* 6; *C.* ∞+23—25+∞; *Vert.* 54—55.

Syn. *Le merlan*, Belon, *Nat., Divers. Poiss.* (1555), p. 120; Duham., *Tr. Pêch.*, part. II, sect. I, p. 128, tab. XXII.

Gadus N:o 1, Art., *Gen.*, p. 19; *Syn.*, p. 34; *Descr. Sp.*, p. 62. Lin., *Fn. Suec.*, ed. I, p. 110; *It. Westrog.*, p. 176; *It. Scan.*, p. 326, tab. 2, fig. 2.

Gadus merlangus, Lin., *Syst. Nat.*, ed. X, tom. I, p. 253; Faber, *Naturg. Fisch. Isl.*, p. 93; Nilss., *Prodr. Ichth. Scand.*, p. 42; Schagerstr., Physiogr. Sällsk. Tidskrift, 1837, p. 300; Fr. et v. Wright, *Skand. Fisk.*, ed. I, p. 81, tab. 18; Nilss., *Scand. Fn., Fisk.*, p. 553; Günth., *Cat. Brit. Mus., Fish.*, vol. IV, p. 334; Lindstr., *Gotl. Fisk.*, (Gotl. L. Hush. Sällsk. Årsber. 1866), p. 26, sep.; Mgrn, Öfvers. Vet.-Akad. Förh. 1867, p. 263; Steind., Stzber. Akad. Wiss. Wien, Math. Naturw. Cl., LVII, I (1868), p. 703; Coll., Vid. Selsk. Forh. Christ. 1874, Tillægsh., p. 108; Winth., Naturh. Tidskr. Kbhvn, ser. III, vol. XII, p. 29; Benecke, *Fisch. Fischer., Fischz. O., W. Preuss.*, p. 88; Day, *Fish. Gt. Brit., Irel.*, vol. I, p. 290, pl. LXXXII; Möb., Hcke, *Fisch. Osts.*, p. 76; Lillj., *Sv., Norg. Fisk.*, vol. II, p. 61; Hansen, *Zool. Dan., Fiske*, p. 69, tab. IX, fig. 5.

Merlangus vulgaris, Flem., *Brit. Anim.*, p. 195; Kr., *Danm. Fiske*, vol. 2, p. 83; Thomps., *Nat. Hist. Irel.*, vol. IV, p. 182; Mor., *Hist. Nat. Poiss. Fr.*, tom. III, p. 239.

Gadus euxinus, Nordm. in Demid., *Voy. Russ. Mér.*, p. 526, *Poiss.*, pl. 26, fig. 2 (vide Steindachner, l. c.).

Merlangus Linnéi, Malm, *Gbgs, Boh. Fn.*, p. 485.

The Whiting is one of the smaller Gadoid species. Most of the Scandinavian specimens are between 20 and 35 cm. in length, though now and then a specimen 55 cm. or more in length is taken, but only on rare occasions.

The form of the body is handsome and well-proportioned. The greatest depth, which measures about 18 or 19 %[4] of the length of the body, occurs at the first dorsal fin. From this point the body tapers gradually and regularly towards the caudal fin, with only a slight distension at the bases of the unpaired fins. The greatest breadth is about half the depth or rather more, from about 9½ to 11 % of the length of the body. The least depth of the body varies, according to our measurements, in different individuals between 4·7 % and 5·3 % of the length of the body or between 38 and 41½ % of the length of the lower jaw.

The head, the length of which is from 25 to 27 % of that of the body, is wedge-shaped, with straight and fairly broad, somewhat convex forehead. The snout is somewhat pointed, though blunt, and projects only a little way in front of the margin of the upper jaw, its length in front of the eyes measuring about 9—9·6 % of the length of the body or 35—37 % of that of the head. The sides of the head are rather flat and smooth, being covered with a thick skin, which entirely covers and conceals the bones of the gill-covers, and, as in most of the Cods, grows out beyond them with age, the postorbital length of the head (including this flap) increasing from about 10½ to 12½ % of that of the body or from about 83 to 96 % of that of the lower jaw. The eyes are middle-sized, their longitudinal diameter varying between about 6 and 4½ % of the length of the body or from about 23½ % to about 16½ % of the length of the head in Whitings between 13 and 41 cm. long. They are round and naked, and are set so high that the line from the tip of the gill-cover to the margin of the upper jaw touches the lower edge of the pupil. The least breadth of the interorbital space alters with individual variations between about 25[a] and and 27 % of the length of the head. The nostrils lie somewhat nearer to the eye than to the snout, just below the outer margin of the forehead. The anterior opening on each side is small and round, with the upper posterior part of the margin raised into a canaliculate flap which rises backwards. The posterior opening is larger, oval, and open, without any elevation of the margin. The mouth is set almost horizontally, with the upper jaw longer than the lower. The gape is large, and admits of considerable expansion, partly by means of the tensile ligaments that unite the apparatus of the jaws to the corners of the mouth, and partly by means of the movable gill-covers and the free branchiostegal membrane. The margin of the upper jaw is formed, as in most of the Physoclysts, by the intermaxillary bones alone, which are shorter than the maxillary bones behind them. The hind extremity of the latter bones is truncate, with a breadth about equal to $^1/_6$ of the length of the lower jaw or, in adult specimens, somewhat less than half the longitudinal diameter of the eye. When the mouth is closed, the entire upper jaw falls into a deep fold formed by a straight, labiate flap which extends on both sides from the snout to a point vertically below the front corner of the eye, to a distance from the tip of the snout only slightly less than the postorbital length of the head or sometimes equal to it. The upper jaw itself surrounds the lower. When the mouth is open, the upper jaw projects a little beyond the tip of the snout. The lower jaw, the length of which is about $12^1/_2$ or 13 % of the length of the body or half[b] that of the head, is generally without any distinct barbel; but under the chin we find a small pointed protuberance or a rudiment thereof, and in a few young specimens a very small and short barbel, which generally escapes observation.

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[1] Sometimes 16, according to Malm.

[2] " 18, " " "

[3] " 30, " " "

[4] Occasionally, in the males, only 16½ %.

Pointed, subulate teeth are present in both jaws and on the head of the vomer; but both the tongue and the palatine bones are smooth. The teeth are set in each jaw in only one regular row, but in the front part of the mouth, in the upper jaw within this row, in the lower jaw outside it, we find numerous smaller and finer teeth in irregular rows. The teeth are somewhat larger in the lower jaw than in the upper, and in the former they are larger at the sides than in front. The tongue is fairly long, cartilaginous, and thick, with narrow, triangular tip.

The hindmost of the four branchial arches is united throughout its whole length to the pectoral wall, the last branchial slit being thus closed on each side. Each arch is furnished in front with two rows of bony tubercles, covered by the mucous membrane, but the outer row on the first arch is made up of true gill-rakers, like narrow lamellæ, which are three times as narrow and long as the other tubercles. The branchiostegal membrane, with its seven rays, is firmly united underneath to the membrane of the other side, but deeply incised; and the margin itself is not united to the isthmus. The gill-cover ends in a point, but this is hidden by the broad flap (a continuation of the branchiostegal membrane) which, as we have mentioned above, forms a margin round the whole of the gill-cover.

The body is covered with small, thin, imbricate scales, set in rather irregular rows. These scales are scarcely visible in living specimens, especially while the surface of the body is moist and covered with mucus; but they grow fairly distinct in large specimens and when the skin has had some time to dry. They also cover the whole head, with the exception of the upper jaw and the extreme upper margin of the lower jaw. On close examination we find that they advance a good way over the caudal fin and imperceptibly disappear towards its end, and also clothe the base of the first anal fin and the branchiostegal membrane, extending a little way along the rays of the latter. Distinct traces of scales may also be found at the front part of the base and the anterior margin of all the other fins.

The course of the lateral line is S-shaped, as in most of the Codfishes, being curved below the second dorsal fin. It forms a continuous, narrow groove, which has, as it were, an articulated appearance, partly on account of the small, short, lateral grooves that jut out at fixed intervals, and partly on account of its being filled up here and there on the tail, and thus to a certain extent effaced.

The vent lies at the end of the first third of the length of the body and a little in front of the perpendicular from the middle of the first dorsal fin.

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[a] Occasionally $24^1/_2$ %.

[b] Sometimes only 48 %.

The pectoral fins lie, when at rest, in a longitudinal direction. Their length is between 13 and 15 % of that of the body, and their rounded tips extend a good way behind the vent. They contain 19 or 20 rays; the uppermost ray is simple, the others branched at the tip, and the fourth and fifth are the longest. The ventral fins, which are set somewhat in front of the pectoral fins, and extend with their tips to the vent, are small and pointed, with the second ray produced to a long, filamentous, free tip, which gives these fins a length of from 9[a] to $10^1/_2$ % of that of the body. They are made up of two simple and four repeatedly branched rays.

The first dorsal fin begins just behind the perpendicular from the insertion of either pectoral fin and at a distance from the tip of the snout equal to about 28—31 % of the length of the body. It most generally contains 13 or 14 rays, the first two of which are simple and the fourth the longest, its length being about 10—$12^1/_2$ % of that of the body. The succeeding rays gradually decrease in length, the last ray being very small. The length of the base of this fin is about $13^1/_2$—11 % of that of the body. The second dorsal fin is composed of about 23 rays, two of which are simple. The fourth and fifth rays are the longest, their length being about 8—10 % (sometimes 11 %) of that of the body; and the other rays grow gradually shorter, the last ray being very short and lying flat along the skin. The distance between this fin and the tip of the snout is about 44 or 45 % of the length of the body, and the length of its base varies between $18^1/_2$ and nearly 23 % of that of the body. The third dorsal fin begins at a distance from the tip of the snout equal to about 65—69 % of the length of the body, just behind the end of the preceding fin, to which it is generally united by a narrow flap of fin-membrane. It generally contains 4 simple and 17 branched rays, the first of the simple ones being scarcely perceptible. The fifth and sixth rays are the longest, their length being from $6^1/_2$ to 8 % (in young specimens sometimes 9 %) of that of the body; and the length of the base of the fin varies between $15^1/_2$ and $13^1/_2$ % of that of the body.

The first anal fin begins at a distance from the tip of the snout equal to about $35^1/_2$—39 % of the length of the body — thus always considerably in front of the beginning of the second dorsal fin. It is long and has an arcuate margin. The length of its base is about 30—34 % of that of the body. It is generally composed of from 33 to 35 rays, eight or nine of which are simple. The 12th—20th rays inclusive are of fairly uniform length and the longest, measuring about 9—7 % of the length of the body; and the succeeding rays grow shorter and shorter. The second anal fin, which is almost exactly opposite the third dorsal, contains 4 simple and (generally) 18 or 19 branched rays, the fifth and sixth rays being the longest.

The caudal fin, as in all the Gadoid species, contains numerous rays, which lie close to each other and radiate from the pointed base of the fin. The middle 23—25 rays are branched, and the middle ray measures 8—7 % of the length of the body. The fin is chisel-shaped, with truncate extremity and rather sharp corners; but when much expanded, the hind margin becomes rounded.

After death the body of the Whiting is nearly plain, grayish brown above and white below; but living specimens and Whitings just drawn out of the water show a play of shifting colours, in spots and stripes. The colour of a middle-aged, live Whiting is fairly accurately shown in our figure (Plate XXIV, fig. 1), and we have nothing more to add than that two specimens are seldom exactly alike in the depth of the colours and the extent of the stripes. In younger specimens the body is more transparent, with the upper part of the sides shading strongly into violet and with fainter traces of the yellowish stripes, which are of a brighter colour, and are woven into a network above the lateral line. The fins are lighter, and all the dorsal and anal fins are silvery white at the very tip. A very large specimen, on the other hand, presents the following appearance: the back and the upper part of the head plain yellowish brown with a handsome, grayish violet lustre; the sides yellowish gray with a dash of violet, with the lateral line and the caudal region just above it of a bright brassy lustre, and with a number of large, distinct, brass-yellow spots along and below the lateral line, which are partly united into a network and partly form irregular, zigzag rows; the entire under surface of the head and tail and the whole belly milky white, with a sharply-marked limit extending to the insertion of the pectoral fins. The iris white, with a lustrous, yellowish ring next the pupil and a broad dark band above and below the latter. The fins plain and of the same colour as the body, the upper ones dark, the lower very pale, with the extreme tip or the margin pure, lustrous white; the pectoral fins yellowish, with the insertion itself white and a blackish spot at the upper part of the axil. This spot, though it varies in distinctness, is always present, and is thus a characteristic of Whitings of all ages. The ventral fins are milky white.

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[a] Sometimes $8^1/_2$ %.

The abdominal cavity extends a good distance behind the vent, almost to the end of the first anal fin. It is lined with a silver-gray membrane of a yellow lustre and thickly strewn with small black dots. The intestinal canal is long, with the stomach produced into a long blind sac and, when empty, of almost the same diameter as the œsophagus, and extending to a line with the vent. The pylorus lies fairly far forward, the pyloric part of the stomach being somewhat compressed and elongated, and the origin of the intestine is furnished with numerous appendages of different lengths, the gall duct opening just in front of them. The intestine subsequently forms four bends before it terminates. The liver is large, of a whitish yellow colour, and is made up of three lobes, the longest of which is of almost uniform breadth and triangular, and extends to the end of the abdominal cavity on the left side. The middle lobe is short and the broadest of the three, with thin edges. The right lobe is somewhat longer than the middle one, but narrow and sharply pointed. Under the base of the last lobe lies the gall-bladder, which in a specimen 50 cm. long is of the size of an acorn, transparent, thin, and filled with a clear, light greenish fluid. The spleen is of a dark chestnut-brown, triangular, and oblong with pointed corners. The ovaries are united at the middle into one single chamber, and the oviduct, which is rather wide, and opens just behind the rectum, issues from the lower wall of this chamber. The testes, as in most of the Cods, are lobate and laid in folds resembling the cerebral convolutions in the Mammals. From the kidneys, which lie along the spine and are supported by the air-bladder, the urethra passes through a fine aperture, and enters the abdominal cavity about half-way between the vent and the end of the cavity. It widens suddenly into an oblong, vesicular duct, which runs forward, again contracts, and opens into a small papilla just behind the genital opening. The air-bladder is very large and extends along the whole dorsal side of the abdominal cavity from beginning to end, being attached on each side by transverse ligaments and covered by the peritoneum. In front, on the inside of the bottom of the air-bladder, we find a large, glandular swelling (vaso-ganglion) furnished with capillary vessels. The air-bladder also sends out in front two long, curved ducts that ascend towards the head.

The geographical range of the Whiting extends at least from North Cape along the west coast of Europe to Spain; and if STEINDACHNER is right, as seems quite probable, in his identification of the species with *Gadus euxinus*, the Whiting is also common in the Adriatic and the Black Sea. HEUGLIN[a] states that he took a specimen of the Whiting off Waigatz (between Nova Zembla and Russia); but up to the present no other instance has been recorded of the occurrence of the species in the Arctic Ocean east of Norway, even in Varanger Fjord, or in the White Sea. Throughout the west coast of Scandinavia the Whiting is plentiful, especially among the islands. It is also common all round Denmark and by no means rare in the south of the Baltic, in certain years at least, as far north as Blekinge. On the coast of Gothland, though there it may be merely an occasional visitor, one specimen was taken off Wisby in the spring of 1865, according to LINDSTRÖM. According to FABER it occurs, though only seldom, on the south coast of Iceland and off the Faroe Islands, but is wanting on the north coast of Iceland. Nor has it been met with off Greenland or on the North American coast. In the Pacific its place is taken by a near relation, *Gadus proximus*.

In the island-belt of Bohuslän the Whiting is one of the commonest species of the genus, and is taken in quantities all the year round. When other fish fail him, the fisherman of Bohuslän can always procure enough Whiting for his daily wants. This fish, especially when the Herring is scarce, thus gives the poor man an unfailing supply of food to fall back upon; and in this capacity the Whiting is of no small service, though its inconsiderable size is a drawback which deprives it, to a considerable extent, of value from a commercial point of view. On the west coast of Scandinavia the Whiting is also an object of sport; and on a fine summer or autumn night one may often see persons row out to fish for Whiting whose means render it a question more of pleasure than of profit.

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[a] Reisen nach dem Nordpolarmeer 1870 und 1871, Th. 3, p. 219.

The Whiting, like all its near relatives, is a fish-of-prey, and may well be regarded as the boldest and most voracious of them all, especially if we take its smaller size into consideration. It lives exclusively by prey, attacking not only feeble victims, such as crustaceans and worms, but principally small fishes. The Herring especially attracts its attention. When large shoals of Herrings enter the island-belts, the Whiting collect and continually annoy this weak and defenceless fish. The movements of the Whiting are fairly quick when in the act of seizing its prey, but at other times it swims slowly, seldom lying still on the watch for some victim, but roving steadily about, letting nothing escape its notice that may serve as food. Though several specimens may often be seen in company, the Whiting does not lead a sociable life, and does not assemble in large shoals even during the spawning-season. It is no great wanderer, but stays all the year round in the neighbourhood of its birthplace and the places that it knows. It prefers fairly deep water with a soft, sandy bottom, and is seldom caught on a rocky bottom, except where small patches of sand occur. The ordinary depth at which the Whiting may be found during the whole summer, is between 12 and 16 fathoms. Towards autumn it ascends into shallower water, and in the month of October the fry and the smaller specimens haunt the shore and the piers at a depth of no more than a foot. Like the Cod it sometimes enters large rivers, at least where there is a layer of salt or brackish water at the bottom; and MALM states that in the River Gotha the Whiting goes up to Hising Bridge, and is often caught by boys fishing at Stora Bommen Bridge in Gothenburg.

About Christmas the ovaries and milt-sacs begin to develop, and in February they have generally reached their full size; but the spawning takes place later in the year, though the season varies considerably. In April one may find some fish that have spawned, others that are ready to spawn, and others still with hard roe. The Whiting does not spawn in so large companies as many other species, especially most fresh-water fishes, but retires quietly out of sight into deep water, so that we have no trustworthy information on this point. However, what we have now learnt of the spawning of the Cod and of the development of its eggs floating in the sea, probably applies on the whole to the spawning and the early stages of the Whiting as well. Early in the summer the eggs are hatched, and the fry may then be seen assembled in fairly great number under the large jelly-fish (*Cyanea capillata*), in which the sea abounds. Thus the fry of the Whiting, like those of the Cod and other fishes, fly for shelter to these creatures, and feed upon the crustaceans which live as parasites in the body of the jelly-fish or adhere to its long, filiform, and slimy tentacles. During the summer it is useless to look for the fry close in shore, and small Whiting from 10 to 12 cm. long may often be seen keeping close to a jelly-fish for hours, following its sluggish movements in a manner that seems to indicate a certain intimacy and mutual confidence between these strangely-assorted companions. From this fact ignorant fishermen draw the false conclusion that the Whiting "is generated" in the jelly-fish and reared by them.

At first the fry grow pretty rapidly, being between 10 and 12 cm. long when they make their way to the shallows in October. Some fishermen are of the opinion that the Whiting is capable of reproducing its species in its second year; but no decisive proof of this is procurable, and the assertion is positively contradicted in other quarters.

During the whole winter the Whiting keeps to its autumn haunts, and does not return to deep water before the spring.

Among all the Gadoid species the Whiting, when cooked fresh, has the finest and most palatable flesh, and is, therefore, in high repute for the purposes of the table. When salted or dried it loses a great portion of its good flavour, and is much inferior to most of the larger species. In Scandinavia it is only seldom cured in the latter manner, and never for sale; but if a fisherman takes a larger quantity of Whiting than he can dispose of fresh or consume himself, he is obliged to have recourse to one of these methods of preserving the remainder for his own use. When dried, the Whiting grows as hard as dry glue, and is therefore known in England as *buckhorn.*

The Whiting-fishery gives employment to most of the island fishermen at the periods when no more important and lucrative fishery occupies their time and attention; and is pursued all the year round by the old and weak, as well as by children, who are incapable of taking part in the more important fisheries, and whose presence is not required there.

The Whiting is taken principally by the hand-line or, as it is called in Bohuslän, the *dörj*. Though only one or at most two fish can be caught at the same time by this method, still this fishery is very productive at spots where the Whiting is plentiful. A few hours are often enough to procure sufficient food for the day's requirements. With hand-lines the Whiting is taken all the year round, the only conditions of success being that the fisherman knows how to choose the fishing-ground according to the time of year and is acquainted with the nature of the bottom. The lines may be used at all hours of the day, but to the best purpose from dawn well into the forenoon and in the evening towards dusk. In summer the lines are plied from a boat which is kept stationary either by putting out a grapnel or by measured strokes of the oars. The latter method of counteracting the wind and current is known in Bohuslän as "*andöfva*[a]." In autumn and winter the fishing is carried on at the landing-places with an ordinary rod, either a "sink-rod" (*sänkspö*) or a float-rod (*flötspö*). Sometimes the fisherman fastens his boat to the pier, and uses a hand-line from the boat. The flesh of a live mussel (*Mytilus edulis*) is the best bait, but it must not be taken out of the shell until required for use. If the mussel is large, it is cut in two. However, as this bait is often difficult to procure or too dear for the fisherman, he has recourse to the expedient of using it only until he catches a fish, and then employing a bait of fresh Whiting cut into slices of suitable length, at which the Whiting bites readily. At a pinch one may begin with other shell-fish, shrimps, worms, or small fishes, for the Whiting is by no means hard to please.

In the seine, especially the large Herring-seine, the Whiting is taken in considerable quantities; but the greater part of the catch is made up of fry or Whiting of small size, and at the seine-fishery no special attention is paid to this fish. In Bohuslän, however, very small seines (*sölvader, kassevader*) are also used to procure all sorts of small fish for the fisherman's daily wants; and this method has been found at the same time less troublesome and more productive than the hand-line. Whiting form the principal part of the catch in these small seines, which can only be used, however, at certain spots, where the bottom is so even that the seine can be drawn ashore without becoming entangled. It is also difficult to employ these seines in summer, on account of the multitude of jelly-fish with which the sea then swarms, and which entirely fill the seine when it is hauled up. In autumn again, the long seaweed gives great trouble by twisting and entangling the whole seine.

The Whiting-fishery is of no inconsiderable value. The home-consumption of Whiting among the fishermen themselves can hardly be estimated with any exactness; but the supply of fresh Whiting brought to Gothenburg Fish Market in the year 1879 is put down by v. YHLEN[b] at 1,607,400 fish of a total value of about 45,000 crowns (£2,500), taking about $2\,^4/_5$ öre ($^3/_8$d.) as the average price of each Whiting. On the Scotch coast during each of the years 1887 and 1888 nearly 4 million Whiting were taken, of an estimated value of between £26,000 and £27,000[c]. (FRIES, SMITT.)

The next two species are so closely related to each other that several writers, not without reason, have united them into one species. We shall also find that the relations of development between them are intimate in the highest degree.

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[a] Old Norwegian *andœfa*, used in the same signification, from *and*, against, and *þæfa*, to press. TR.

[b] Intern. Fisch. Ausst. Berlin 1880, Swedish Catal., Append. I.

[c] Fish Trades Gazette, vol. VI, No. 297 (26th Jan., 1889), p. 8.

THE BIB (SW. SKÄGGTORSKEN).

GADUS LUSCUS.

Plate XXII, A, fig. 2.

Length of the base of the first anal fin more than half the distance between this fin and the tip of the snout. Upper jaw most prominent. Length of the lower jaw at least about 44 % of that of the head, which (at least in adult specimens) is more than 24 % of the length of the body. Least depth of the tail (at least in adult specimens) more than 5 % of the length of the body, than 49 % of the length of the lower jaw, than 51 % of the distance between the tip of the snout and the hind extremity of the maxillary bones, or than 44 % of the length of the base of the third dorsal fin. Distance between the tip of the snout and the hind extremity of the maxillary bones more than 84 % of the length of the lower jaw, but less than the length of the ventral fins. Length of the snout less than 8 % of that of the body, than 66 % of the postorbital length of the head, or than 64 % of the length of the lower jaw. Greatest depth of the body more than $^1/_4$ of its length, and the greatest thickness, which is about equal to the postorbital length of the head, more than 11 % of the length of the body. Coloration above yellowish brown or red, belly white; lateral line only slightly, if at all, darker[a] *than the colour of the body; a blackish spot at the upper part of the base of the pectoral fin.*

R. br. 7; *D.* 12—14|22[b]—26|18—20; *A.* 27—30[c]|18[d]—21; *P.* 19[d]—20; *V.* 6; *C.* x + 20—22 + x; *Vert.* 48.

Syn. *Asellus luscus*, Willughby, *Hist. Pisc.*, p. 169. *Tacaud*, Duham. *Tr. Pêch.*, part II, sect. I, p. 136, tab. 23, fig. 2.

Gadus, No. 6, Art., *Gen.*, p. 21; No. 5 et 12, *Syn.*, p. 35 et 37; No. 6, *Spec.*, p. 65.

Gadus luscus, Lin., *Syst. Nat.*, ed. X, tom. I, p. 252; *Mus. Ad. Frid.*, tom. II prodr., p. 69; (?) Faber, Tidskr. Naturv., Kbhvn, vol. V (1828), p. 219; Jenyns, *Man. Brit. Vert. Anim.*, p. 442; Fries, *Skand. Fisk.*, ed. I, p. 78; (?) Kr., *Danm. Fiske*, vol. II, p. 77; Nilss., *Skand. Fn.*, *Fisk.*, p. 545; Gthr, *Cat. Brit. Mus.*, *Fish.*, vol. IV, p. 335; Malm, (*Gadulus*), *Gbgs*, *Boh. Fn.*, p. 482; Mor. (*Gadus*), *Hist. Nat. Poiss. Fr.*, tom. III, p. 233; Day, *Fish. Gt. Brit.*, *Irel.*, vol. I, p. 286, tab. LXXX; Petersen, Vid. Meddel. Naturh. For. Kbhvn 1884, p. 157; Lillj., *Sv.*, *Norg. Fn.*, *Fisk.*, vol. II, p. 68; Hansen, *Zool. Dan.*, *Fiske*, p. 65, tab. IX, fig. 2.

Gadus barbatus, Lin., (p. p.) *Syst. Nat.*, l. c.; Bloch (Der breite Schellfisch), *Naturg. Ausl. Fisch.*, part. 2, p. 105, tab. CLXVI; Esm., Skand. Naturf. 4:de Möde, Christ. 1844, Forh., p. 230; Malm, Gbgs Vet., Vitt. Samh. Handl., N. Tidsf., H. 2, p. 107 c. tab.

Gadus minutus, Steind., Stzber. Akad. Wiss. Wien, Math. Naturw. Cl., LVII, i (1868), p. 704; Winth., Naturh. Tidskr. Kbhvn, ser. 3, vol. XII, p. 29; Mor., l. c., p. 231.

The Bearded Cod (*Skäggtorsken*) or Broad Cod (*Bredtorsken*), as Nilsson called it, has been well-known, ever since the times of Willughby and Duhamel, to English zoologists by the trivial names of Bib, Blinds, and Whiting Pout, and in France by that of *Tacaud*. Among the Cods it has the deepest and (in proportion to the depth) most compressed body, as well as the relatively longest barbel. The name of *luscus* is derived from the loose membrane over the eyes, which generally swells and grows more and more opaque after the death of the fish. The skin of the fins too, especially at their bases, is sometimes much swollen, loose, and slippery.

According to Malm, who had the opportunity of examining the fish during life and just after its capture, the colour of the upper half of the body is reddish brown with a faint dash of yellow, that of the lower half lighter, with a bluish gray tinge, but passing towards the belly into whitish. The whole body, except the extreme ventral margin, is finely strewn with small, blackish brown dots. The sides of the body have a lustre of gold or silver, sometimes with a greenish tinge. The lateral line is golden yellow, but for the first half of its length brownish. The fins, according to Day, are bluish black and darkest at the margins. This coloration is sometimes diversified, however, by transverse bands across the body, traces of which may be found in one of the specimens sent by Mr. Hansson from Strömstad to the Royal Museum. Day speaks of five or six of these dark, broad bands, but Moreau of three broad, whitish gray ones. The iris, according to Malm, is brown with a golden lustre, but has a narrow, brassy ring next the pupil.

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[a] In specimens preserved in spirits lighter.

[b] Sometimes 20, according to Günther.

[c] ,, 35, ,, ,, Jenyns.

[d] ,, 17, ,, ,, Moreau.

The Bib is one of the rarest fishes in Scandinavia, and has only been met with a few times, in most instances on the coast of Bohuslän. In May, 1827, it is true, Faber (l. c.) took a Cod off the Skaw that was determined at the Museum of Copenhagen as a *Gadus luscus;* but the specimen is missing, and Faber's description is not enough to decide the question whether the specimen belonged to this species or to the following one[a]. Fries, in the first edition of this work, was the first to include the Bib with certainty in the Scandinavian fauna, on the strength of a specimen that he received at Fiskebäckskil (Bohuslän) in November, 1836. This specimen was 32 cm. long, and is still preserved in the Royal Museum. At a more recent period, between 1849 and 1874, Malm received 6 specimens, all solitary, from the southern island-belt of Bohuslän, which were between 20 and 33 cm. long. Mr. C. A. Hansson has furnished the Royal Museum with two specimens, a female from Säcke Fjord, taken in August, 1880, in 40 or 50 fathoms of water, and a male, taken in Strömstad Fjord, in August, 1882. Both these specimens are 30 cm. long. The Bib is no less rare in Denmark, though, according to Petersen, it has been found in recent years once (in 1880) off the Skaw, and once (1884) off Agger. On the Norwegian coast it has not yet been observed. All round Great Britain and Ireland, on the other hand, it is common, and still commoner further south, in the Channel and on the west coasts of France and the Spanish Peninsula. On the Mediterranean coast of France, according to Moreau, it is rare, and is only occasionally met with, according to Giglioli[b], on the coast of Italy.

"It adheres," says Day, "pertinaciously to one spot, according to Mr. Dunn, who observes that it is largest and in the best condition when residing among rocks upon precipitous coasts as Cornwall. Here it seeks a secluded crevice or gully where it conceals itself during the day time, sometimes thousands seeking the same spot. At twilight it sallies out, as it usually feeds only at night time, extending its excursions over the high grounds and on to the low rocks and sands beyond, but not going very far. Assemblages of these fish are known as "chains of bibs," two or more of which may be found so close together as to be merely divided by a ledge of rock of a few feet in width; one chain of bibs may be light coloured and the contiguous one banded with dark. In mild winters it remains in these haunts, but if cold and stormy it retires to the deep sea, returning again in spring. It also appears partial to living inside wrecked vessels. It prefers rough ground or shelving rocks arising from a sandy soil. The knowledge of the exact localities where these fish reside has been kept in some fishermen's families for generations. It thrives pretty well in an aquarium, but after a time becomes of a lighter colour." It lives on small fishes, crustaceans, and mollusks. The spawning-season occurs in spring. It is taken in the same way as the other species of this family; and large Bibs — Yarrell[c] saw a specimen 16 in. long, and Blake[d] states that they attain a weight of 4 lbs. — are excellent eating.

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[a] "The second dorsal fin of the same shape as the first anal and set opposite it." The greatest depth of the body (24·1 % of its length) also points to *Gadus minutus;* but the depth of the tail in front of the caudal fin (5·5 % of the length of the body) refers the specimen to *Gadus luscus.*

[b] Espos. Intern. Pesca. Berlino 1880, Sez. Ital., Cat., p. 96.

[c] *Hist. Brit. Fish.*, ed. 2, vol. II, p. 239.

[d] Zoologist. 1866, p. 507.

THE POOR, OR POWER COD (SW. GLYSKOLJAN).

GADUS MINUTUS.

Plate XXIV, fig. 2.

Length of the base of the first anal fin more than half the distance between this fin and the tip of the snout. Upper jaw most prominent. Length of the lower jaw at least about 48 % of the length of the head, which is less than 24 % of the length of the body. Least depth of the tail less than 5 % of the length of the body, than 43 % of the length of the lower jaw, than 46 % of the distance between the tip of the snout and the hind extremity of the maxillary bones, or than 31 % of the length of the base of the third dorsal fin. Distance between the tip of the snout and the hind extremity of the maxillary bones, more than 88 % of the length of the lower jaw, but less than the length of the ventral fins. Length of the snout less than 8 % of that of the body, than 70 % of the postorbital length of the head, or than 62 % of the length of the lower jaw. Greatest depth of the body generally less than 1/4 of its length, and the greatest thickness, which is about equal to the postorbital length of the head, less than 11 % of the length of the body. Coloration like that of the Whiting, but without the black spot at the base of the pectoral fin, or with only a faint trace thereof.

R. br. 7; *D.* 12—15 19—25 19[a]—24; *A.* 25—31 20[a]—22[b]; *P.* 17—19; *V.* 6; *C.* $x+19-23+x$; *Vert.* 50.

Syn. *Asellus mollis minor l. omnium minimus*, WILLUGHBY, *Hist. Pisc.*, p. 171 (e mari Mediterraneo): JAGO apud RAIUM, *Syn. Meth. Pisc.*, p. 163 (e littore cornubiensi).

Gadus No. 7, ART., *Gen.*, p. 21: No. 8, *Syn.* p. 36 (ex WILL. et JAG.).

Gadus minutus, LIN., *Syst. Nat.*, ed. X, tom. I, p. 253 (ex ART.); JENYNS, *Man. Brit. Vert. Anim.*, p. 444; FRIES, *Skand. Fisk.*, ed. I, p. 78, v. WRIGHT, tab. 17; KR., *Danm. Fiske*, vol. II, p. 61; NILSS., *Skand. Fn.*, *Fisk.*, p. 547; THOMPS., *Nat. Hist. Irel.*, vol. IV, p. 181: GTHR, *Cat. Brit. Mus.*, *Fish.*, vol. IV, p. 335; STEIND., Stzber. Akad. Wiss. Wien, Math. Naturw. Cl., LVII, I (1868), p. 704; COLL., Forh. Vid. Selsk. Christ. 1874, Tillægsh., p. 109; ibid. 1879, No. 1, p. 66; MALM (*Gadulus*), *Gbgs. Boh. Fn.*, p. 484; WINTH. (*Gadus*), Naturh. Tidskr. Kbhvn, ser. III, vol. XII, p. 29; DAY, *Fish. Gt. Brit.*, *Irel.*, vol. I, p. 288, tab. LXXXI. MÖB., HCKE, *Fisch. Osts.*, p. 77; STORM, Norsk. Vid. Selsk. Skr. (Trondhj.) 1883, p. 33; PETERSEN, Vid. Meddel. Naturh. Foren. Kbhvn 1884, p. 157; LILLJ., *Sv.*, *Norg. Fisk.*, vol. II, p. 76; HANSEN, *Zool. Dan.*, *Fiske*, p. 66, tab. IX, fig. 3.

Gadus luscus, BL., *Syst. Ichth.*, posth. ed. SCHNEIDER, p. 8, tab. 2; NILSS., *Prodr. Ichth. Scand.*, p. 41: SCHAGERSTR., Physiogr. Sällsk. Tidskr. (1838), p. 298.

Obs. Like the Bib the Poor, or Power Cod of the English fishermen and the *capelan* of the French has been best known and easiest to determine, from remote times, by these names, given it originally by fishermen and in trade. WILLUGHBY and RAY did not know the English form, and on their authority LINNÆUS clung to the opinion that *Gadus minutus* occurred only in the Mediterranean. JAGO had, however, referred both forms to the same species; and ARTEDI approved of this identification, but suffered the species to retain an incorrect character (*ano in medio corporis*) which was one of the causes that betrayed BLOCH (*Fische Deutschlands*, II, p. 167, tab. LXVII, fig. 1) into confounding *Gadus minutus* with a young *Gadus callarias*. In this way *Gadus minutus* was introduced into the Swedish fauna in RETZIUS's edition of the *Fauna suecica* of LINNÆUS (p. 319); and when NILSSON in his *Prodromus* undertook to correct the mistake, he consulted BLOCH's posthumous work, where a Poor Cod is evidently figured under the name of *Gadus luscus*.

The Poor Cod is one of the two smallest species of this genus that still inhabit Scandinavian waters. Its length is usually between 15 and 20 cm., and seldom exceeds 23 cm.[c] That which distinguishes the Poor Cod at the first glance from most of the other species, is the deeper and more compressed form of the body, the eminently large eyes, the large and distinct scales, and the plain colour of the body.

The greatest depth of the body, which in this species occurs between the beginning of the second dorsal fin and the vent, is in young specimens about equal to the length of the head, but in old somewhat greater, thus varying between 19 1/2 and 24 1/2 % of the length of the body. The greatest breadth (thickness) is about equal to half the greatest depth or somewhat less, and we have never found it to be quite so much as 11 % of the length of the body, though very nearly so.

The forehead is slightly convex, and curves downward towards the short, blunt, and sloping snout. The length of the head is between about $22^1/_2$ and $23^1/_2$ % of that of the body. The length of the snout, as in the Bib, measures about 28—30 % of that of the head, but is always at least somewhat less than the longitudinal diameter of the eyes, though these two measurements may approach each other so closely as to represent respectively 6·6 and 6·7 % of the length of the body or 29·6 and 30·1 % of that of the head. The eyes are very large, their longitudinal diameter varying between about 34 and 30 % of the length of the head. Their position is the same as in the Whiting; but the distance between them is much less than their diameter. The nasal cavities lie just in front of the eyes, and the anterior nostrils are, as it were, cucullate. The mouth is turned obliquely upward, but in other respects resembles that of the Whiting, though the upper jaw is not so long in proportion to the lower. The intermaxillary teeth form a card, which grows narrower behind, and contains teeth of uniform size; but in the outer row we find a few (4—6), large, scattered canines, smaller and more scattered than in the Bib. In the under jaw, as in the case of the Bib, there are only two rows of teeth, those in the inner row being larger and more scattered. On the head of the vomer the teeth are set in a curve, or a broad angle, open behind. The tongue is small, sharply rounded, spatulate, and free only at the extreme margin. Under the chin we find a fairly long barbel, which is, however, shorter than in the Bib, and measures less than the diameter of the eye. The branchiostegal membrane is inferiorly rather broad and only slightly incised; the rays are sometimes 8 in number, but generally, as in most of the Cods, only 7. The branchiostegal membrane is more rounded on the sides of the head than in the Whiting, with a pointed corner at the top, in which lies the tip of the gill-cover, here almost imperceptible, but in the Bib more distinct and pungent.

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[a] Sometimes 17, according to LILLJEBORG.

[b] Sometimes 23, according to KROYER.

[c] NILSSON, according to his own statement, however, had seen a specimen 26 cm. in length.

The scales are larger than those of the Whiting. They are imbricate, and set in fairly regular rows, but are loosely attached and deciduous. They are thin and show regular striations. If we begin to count at the vent, and follow an arcuate row of scales to the lateral line, this row proves to contain about 39 scales. The scales cover half the caudal fin; and very small ones may be found covering the bases of the other vertical fins and the outer surface of the base of the pectoral fins. The lateral line curves distinctly upwards, as in the Whiting, and is of similar structure.

The vent lies about opposite the beginning of the second dorsal fin, and generally a little behind the end of the first third of the length of the body.

The pectoral fins are pointed, of a lancet shape, and extend a good way behind the vent, their length being about 15—17 % of that of the body. They contain 2 simple rays and 15—17 branched at the tip. The third and fourth rays are the longest, the following ones gradually decreasing in length. The ventral fins are set just in front of the perpendicular from the base of the pectoral, are narrow, long, and very pointed, their length being about $11^1/_2$—$14^1/_2$ % of that of the body, and extend behind the vent. They are composed of 6 rays, the first two long and simple, with free tip, the second longest, and the others gradually diminishing in length and branched at the tip.

The first dorsal fin begins almost vertically above the insertion of the pectoral fins, rises into a triangle with rounded apex, and is higher than the second dorsal, its height being greater than its length at the base, and measuring about $14^1/_2$—16 % of the length of the body, while its length is only $10^1/_2$—12 % thereof. It contains 2 or 3 simple, and from 10 to 12 branched rays. The third ray is the longest, the others gradually decreasing in length. The second dorsal fin rises straight up in front and slopes evenly behind. Its length is about 25—27 % of the length of the body, and its height about 11—13 % of the latter length. It is made up of 2 simple, and (generally) 19 or 20 branched rays, with the second ray longest. The third dorsal fin is of the same shape as the second, but much shorter, though sometimes of the same height. It contains 3 or 4 simple rays and (generally) 16 or 18 branched ones, the first of the latter being the longest ray in the fin.

The first anal fin is almost exactly analogous to the second dorsal, but is of somewhat greater extent, and in young specimens of somewhat greater, in old of equal or somewhat less height. Its length is about 27—31 %, and its height about 13—11 % of the length of the body. The anterior corner is also much more rounded, the sixth ray being usually the longest. It is composed of 5 or 6 simple, and (generally) 20—23 branched rays. The second anal fin is of about the same shape as the third dorsal, which it also resembles almost exactly in other respects. Its length is about 18—$15^1/_2$ % of that of the body, its height about 8—12 % of the latter length. It contains 3 simple, and (generally)

18 or 19 branched rays. The fourth or fifth ray is the longest.

The caudal fin is slightly forked, but when it is expanded to its full size, the hind margin is quite straight.

The internal organs show no essential differences from those of the Whiting, except that the peritoneum is more densely mottled with black, and that the pyloric appendages are somewhat fewer in number.

During life the Poor Cod is a handsome fish enough, though its colour is more monotonous than that of most of its relatives. As is the case with most fishes, the colour fades soon after death, its brilliancy is lost, and the appearance of the fish is entirely changed. Our figure (Plate XXIV, fig. 2) is a fairly accurate representation of the true colour of the Poor Cod during life, with all its phases, and we need, therefore, do little beyond referring the reader to the figure. The whole of the upper part of the body, above the lateral line, is of a peculiar, yellowish brown colour, which gradually grows lighter down the sides, with a marked coppery lustre. The belly is of a somewhat dark, silvery gray, shading distinctly into brassy yellow up the sides. The fins are rather dark, of the general colour of the body but lighter at the margin, and like the body are thickly strewn with fine, black dots.

The Poor Cod (Sw. *glyskoljan* or *glysan*, Norw. *kolje*) occurs rather sparingly, though it is not rare, on the coasts of Scandinavia. Its range is really confined to the western islands, from Trondhjem Fjord south along the coasts of Norway and Bohuslän. In the Cattegat is goes as far as Kullen and along the Swedish side of the Sound. Möbius and Heincke state that on one occasion, in November, 1874, three specimens between 18 and 23 cm. long were taken off Kiel. On the coasts of Great Britain and Ireland it is more common, and probably on the north-west coast of France, though Moreau remarks that he never succeeded in procuring a specimen thence. Steindachner found the species both on the west and east coasts of the Spanish Peninsula; and, as we shall soon see, there is scarcely any reason for establishing a specific distinction between the Poor Cod and the "*capelan*," which sometimes occurs in enormous numbers on the Mediterranean coast of France, and according to Giglioli and Ninni[a] is common on both sides of Italy.

As the Poor Cod frequents fixed and rather circumscribed localities, where it collects in companies and has its true home, our success in finding it depends on our previous knowledge of these localities, unless we hit upon them by accident. These haunts of the Poor Cod lie in deep water, at a depth of about 12—20 fathoms, and on a sandy bottom, close to precipitous shelves of rock. According to the fishermen it stays here all the year round, and undertakes no long journeys.

The Poor Cod is said to spawn in the first days of spring, as in February and March the ovaries are full. Risso[b] gives April and May as the months in which the Mediterranean *capelan* is full of roe. Though we have as yet no further trustworthy information of the manner in which the spawning is performed, we may assume that the Poor Cod differs only slightly in this respect from the other species of the genus.

Neither this fish nor its fry are ever seen close in shore; and that it does not frequent the littoral region, under ordinary circumstances at least, is shown by the fact that it is never taken in the seine. It lives on small victims, consisting chiefly of crustaceans and mollusks. Its flesh is fine and of good flavour, and is consumed in the same way as that of the Whiting. The insignificant size of the fish renders it better adapted, however, to be used as bait for the larger Cods.

The only tackle used in Scandinavia in fishing for the Poor Cod is the hand-line or *dörj*. By using quite small hooks and a bait of common mussel, the Poor Cod may be taken freely, for it both bites readily and is easily hooked. To ensure success, however, one must have an accurate knowledge of the haunts of the fish, and the hook must be held close to the bottom. On the English and Irish coasts the Poor Cod is taken pretty frequently in the trawl or in crab and lobster pots. In the Mediterranean it is caught principally in the *gangui*, an engine which in construction and manner of employment is a compromise between the seine and the trawl. (Fries, Smitt.)

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[a] See the Italian Catalogue of the Fisheries Exhibition at Berlin in 1880.

[b] *Eur. Mérid.*, tome III. p. 226.

The question still remains whether the Bib and the Poor Cod are really distinct species. Up to this point we have followed the opinion maintained by **Fries** in the former edition of this work and the generally accepted one. In most cases too, the characters given in the above diagnoses should be sufficient to prove the specific distinction. **Steindachner** has remarked, however, that the difference in the depth of the body is merely a character of age[a]. He has also referred to the same category the character given by **Moreau** and **Günther** and derived from the distinct separation of the anal fins in *Gadus minutus* and their union in *G. luscus*. The length of the snout in proportion to that of the body affords no constant difference, though it follows the rule of the changes of growth and is greater in the larger Bib; and the size of the eyes has been long since ascertained to undergo a relative diminution with increasing age. We are further met by the individual variations. Thus, in the largest Poor Cod measured by **Krøyer** the greatest depth of the body, contrary to the general rule, is at least somewhat greater than the length of the head; and this variation goes still further in one of **Fries**'s type-specimens of this species which is still preserved in the Royal Museum. In this specimen, which is 163 mm. long, the greatest depth of the body is 24 % of its length, while the length of the head is only $22^1/_2$ % thereof. In the largest specimen from Christiania Fjord examined by **Collett**, the length of the head was somewhat less than 22 % of the length of the body, but the greatest depth very nearly 26 %.

The natural connexion between the forms is best illustrated, however, by a reference to the average changes of growth in the relations which apparently show constant differences. Partly on this account, and partly instead of a fuller description of the Bib, we here give the following table.

	Average in			Maximum or minimum in these specimens	
	Gadus minutus		*G. luscus*		
	3 specimens.	2 specimens.	3 specimens.	*G. minutus*	*G. luscus*
Length of the body expressed in millimetres	152	207	305	—	—
,, ,, ,, head in % of the length of the body	22.9	23.0	24.7	<24	>24
Distance between the first dorsal fin and the tip of the snout ,, ,, ,, ,, ,, ,, ,, ,,	27.1	27.5	29.6	—	—
,, ,, ,, second ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,,	37.8	38.9	43.3	<40	>42
,, ,, ,, third ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,,	63.5	63.5	66.8	-	—
Length of the base of the third dorsal fin ,, ,, ,, ,, ,, ,, ,, ,,	16.9	16.1	13.0	>15	<14
,, ,, ,, ,, ,, ,, first anal ,, ,, ,, ,, ,, ,, ,, ,, ,,	27.7	29.8	35.6	<32	>33
,, ,, ,, pectoral fins ,, ,, ,, ,, ,, ,, ,, ,,	15.7	16.2	18.0	<17	>17
,, ,, ,, ventral ,, ,, ,, ,, ,, ,, ,, ,, ,,	12.1	14.2	15.6	<15	>15
Longitudinal diameter of the eyes ,, ,, ,, ,, ,, ,, ,, ,,	7.4	7.2	6.5	—	—
Breadth of the hind extremity of the maxillary bones ,, ,, ,, ,, ,, ,, ,, ,,	2.0	2.4	2.7	<2.5	>2.6
,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, lower jaw	18.2	20.6	22.7	<21	>21
,, ,, ,, ,, ,, ,, ,, ,, ,, in % of the longitudinal diam. of the eye	28.4	33.7	40.7	<35	>38
Breadth of the interorbital space in % of the base of the third dorsal fin	31.3	34.4	43.9	<35	>42
Length of the snout in % of that of the base of the first anal fin	23.9	22.3	19.9	—	—
Distance between the ventral fins and the beginning of the first anal fin in % of the length of the body	15.5	15.2	11.7	—	—
,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, pectoral fin	98.7	95.3	65.2	>84	<76
,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, base of the first anal fin	55.9	51.9	32.8	>46	<38
Base of the first anal fin in % of the distance between this fin and the tip of the snout	75.1	83.2	99.2	<85	>86
,, ,, ,, second ,, ,, ,, ,, ,, ,, base of the first	61.3	53.2	44.2	>49	<47
Least depth of the tail in % of the length of the body	4.4	4.7	6.0	<5	>5
,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, middle rays of the caudal fin	51.1	56.0	60.3	<57	>57
,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, snout	66.3	71.5	84.7	<77	>77
,, ,, ,, ,, ,, ,, ,, ,, ,, distance from the tip of the snout to the hind extremity of the maxillary bones	40.3	43.3	56.5	<45	>51
,, ,, ,, ,, ,, ,, ,, ,, ,, length of the lower jaw	38.5	40.4	52.3	<42	>49
,, ,, ,, ,, ,, ,, ,, ,, ,, base of the first dorsal fin	37.2	43.2	51.1	<45	>48
,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, third ,,	26.0	29.6	48.2	<30	>44
Greatest thickness of the body in % of its length	10.5	10.6	12.2	<11	>11

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[a] Even **Krøyer**'s measurements show the following result in *Gadus minutus*:

Length of the body expressed in millimetres	173	190	222
Greatest depth of the body in % of the length of the body	21.4	22.3	23.5

Throughout this table, where the averages in *Gadus minutus* increase with age, the averages are greater in *Gadus luscus* than in the former species; and where the averages decrease with age in *Gadus minutus*, they are also less in *Gadus luscus*. Thus the two species, if one chooses to call them so, stand in a very intimate developmental relation to each other; and the gaps between the maximum and minimum proportions given above would no doubt have been filled in most cases, if not in all, if we had been enabled to examine younger specimens of *Gadus luscus*. Between the largest specimen of *Gadus minutus* (210 mm. long) in the possession of the Royal Museum and the smallest specimen of *Gadus luscus* (297 mm. long) the gap is sufficiently wide to admit of considerable changes of growth.

We have just seen how *Gadus navaga* and *G. gracilis* afford the same example of almost identical forms whose right to the position of independent species may well be questioned, the resemblance between them being so close that the existing differences may well be regarded as the expression of local variations. The case is the same here. The true home of the Bib evidently lies round the British coasts, for to the north and south it becomes rarer and rarer, the further we go from this centre; but in Scandinavian waters and, still more frequently, in the Mediterranean its juvenile stages occur with a certain degree of independence in form and colour. That these younger forms, even in English waters, should keep apart from the older ones, at different depths and, in most cases, on different bottoms, coincides with our knowledge of the other Codfishes at different ages. Finally, to judge by the observations made up to the present, the Mediterranean *capelan* is distinguished from the Scandinavian Poor Cod only by its still closer affinity to the Bib.

The following group in the Scandinavian fauna contains three species, one of which, *Gadus Esmarkii*, never attains the same size as the others, and retains several characteristics in common with their juvenile stages. Still, it is distinguished from them in several respects by the distinct direction of its development, and also by the persistency of the barbel under the chin even in its adult state. *Gadus Esmarkii* thus ranges itself nearer the common origin of all the Cods; and of the true Coalfishes, the Pollack and the Coalfish, the latter is the further advanced in those respects in which all three species show a common direction of development. This appears most distinctly, according to our investigations, in the following respects:

Average in	*Gadus Esmarkii.*		*Gadus pollachius.*		*Gadus virens*	
	2 specimens.	3 specimens.	3 specimens.	3 specimens.	3 specimens.	2 specimens.
Length of the body expressed in millimetres	111	173	204	362	105	300
Least depth of the tail in % of the length of the lower jaw	30.1	33.2	40.8	41.1	43.7	44.9
Length of the snout ,, ,, ,, ,, ,, ,, ,, ,, ,,	50.3	53.3	56.0	58.9	65.1	69.3

THE COALFISH (SW. GRÅSEJEN).

GADUS VIRENS.

Plate XXIV, fig. 4.

Length of the base of the first anal fin more than half the distance between this fin and the tip of the snout. Lower jaw most prominent (though sometimes only slightly), its length being at least about 46 % of that of the head, but less than 13 % of that of the body. Distance between the tip of the snout and the hind extremity of the maxillary bones at most about 77 %, but at least about 72 %, of the length of the lower jaw, and greater than the length of the ventral fins, which is less than twice the least depth of the tail, this depth being more than 36 % of the length of the lower jaw, than 35 % of the base of the third dorsal fin or of the length of the pectoral fins, but less than 80 (76?) % of the least breadth of the interorbital space. Distance between the first dorsal fin and the tip of the snout at least about 30 % of the length of the body. Length of the snout more than 62 % of that of the lower jaw, but less than 70 % of the postorbital length of the head. Length of the middle rays of the caudal fin less than $6^1/_2$ % of the length of the body. Lateral line only slightly and gradually curved and of a light colour.

R. br. 7; *D.* 12—14[a]/19—24/19—22; *A.* 23—27[b]/20[c]—23; *P.* 19—20[d]; *V.* 6; *C.* x+23—28+x; *Vert.* 54—55.

Syn. *Colfisch*, BELON, *Nat.*, *Div. Poiss.* (1555) p. 128.

Asellus niger, *Carbonarius* (p. 19) et *Asellus virescens* (p. 20), SCHONEV., *Ichth. Slesv. Hols.* (1624).

Gadus dorso tripterygio, ore imberbi, maxilla inferiore longiore et linea laterali recta, ART., *Gen.*, p. 20; *Syn.*, p. 34.

Gadus dorso tripterygio, ore imberbi, dorso virescente, LIN., *Fn. Suec.*, ed. I, p. 111; GRON., Act Ups. 1742, p. 90.

Gadus virens, LIN., *Syst. Nat.*, ed. X, tom. I, p. 253; ASC., *Icon. Rer. Nat.*, cah. III, tab. XXIII; MÜLL., *Zool. Dan. Prodr.*, p. 42; FABER, *Fische Isl.*, p. 99; NILSS., *Prodr. Ichth. Scand.*, p. 43; SCHAGERSTR., Physiogr. Sällsk. Tidskr., p. 301; NILSS., *Skand. Fn.*, *Fisk.*, p. 559; GTHR, *Cat. Brit. Mus.*, *Fish.*, vol. IV, p. 339; COLL., Forh. Vid. Selsk. Christ. 1874, Tillægsh., p. 111; ibid. 1879, No. 1, p. 66; N. Mag. Naturv. Christ., Bd. 29, p. 82; MALM (*Pollachius*), *Gbgs, Boh. Fn.*, p. 488; WINTH. (*Gadus*), Naturh. Tidskr. Kbhvn, ser. III, vol. XII, p. 31; DAY, *Fish. Gt. Brit.*, *Irel.*, vol. I, p. 293, tab. LXXXIV; JORD., GILB., Bull. U. S. Nat. Mus., No. 16, p. 806; MÖB., HCKE, *Fisch. Osts.*, p. 79; LILLJ., *Sv.*, *Norg. Fn.*, *Fisk.*, vol. II, p. 83.

Gadus carbonarius, LIN., *Syst. Nat.*, ed. X, tom. I, p. 254; MÜLL., l. c., p. 43; FABER, l. c., p. 96; NILSS., *Prodr.*, p. 44; SCHAGERSTR., l. c.. DEK. (*Merlangus*), *N. York Fn.*, part. IV, p. 287, tab. XLV, fig. 144; KR., *Danm. Fisk.*, vol. II, p. 102; EKSTR., v. WRIGHT, (*Gadus*), *Skand. Fisk.*, ed. I, p. 195, tab. 48; THOMPS. (*Merlangus*), *Nat. Hist. Irel.*, vol. IV, p. 183; MOR., *Hist. Nat. Poiss. Fr.*, tom. III, p. 243; BR. GOODE (*Pollachius*), *Fisher.*, *Fishery Industr. U. S.*, Sect. I, p. 228, tab. 60.

Colin, DUHAM., *Tr. Péch.*, part. II, sect. I, p. 125, tab. XXI, fig. 1.

Gadus purpureus, MITCH., Trans. Lit., Phil. Soc. N. York, vol. I, p. 370; (?) DEK., l. c., p. 286, tab. XLV, fig. 147; STORER (*Merlangus*), Mem. Amer. Acad. Arts, Sc., n. ser., vol. VI, p. 358, tab. XXVIII, fig. 3.

Gadus leptocephalus, DEK., l. c. p. 288, tab. XLV, fig. 146.

Obs. Even FABER (l. c.) suspected that the Linnæan species *Gadus virens* and *G. carbonarius*, distinguished originally by SCHONEVELDE (l. c.), were merely different stages of growth of the same species, the younger Green Cod (*virens*) lighter in colour than the older Coalfish (*carbonarius*). FRIES, however, to the best of our knowledge, was the first (see the 1st Ed. of this work, p. 77) positively to maintain the correctness of this opinion. KRØYER (l. c.) has since given the fullest possible elucidation of this question.

The Coalfish (Sw. *Sej*, or, as it is most frequently called, *Gråsej*, to distinguish it from the next species,) even in Scandinavia attains a length of more than a metre[e]; but the smaller specimens which are most common in the island-belt of Bohuslän, are between 20 and 30 cm. long.

The body is of a handsome form, tapering at both ends, plump, somewhat compressed, and so deep that the greatest depth, which occurs at the end of the first dorsal fin, is between $^1/_5$ and $^1/_4$ of the total length of the body. The thickness, measured at the same point, is about half the depth. The least depth of the body, just in front of the caudal fin, is on an average only slightly more than 5 % of its length. The back as well as the belly is rather thick and convex throughout its length.

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[a] Sometimes 15, according to KRØYER.

[b] „ 29, „ „ LILLJEBORG.

[c] „ 18, „ „ EKSTRÖM.

[d] „ 21, „ „ KRØYER.

[e] The largest specimen MALM obtained on the coast of Bohuslän was $11^1/_2$ dm. long. The largest specimen that KRØYER ever saw, was of the same length (44 Dan. inches).

The head is of a pointed, cuneiform shape and middle-sized, its length being in young Coalfish about 26 %, in adult ones 24—$23^{1}/_{2}$ %, of the length of the body. In young specimens the eyes are fairly large, measuring nearly $^{1}/_{4}$ of the length of the head, but in older ones this proportion sinks almost to $^{1}/_{6}$. They are set so high that the line drawn from the tip of the snout to the middle of the caudal fin cuts the eye into two equal parts. The distance between the eyes, which is about 7 % of the length of the body, may be equal in young specimens to the length of the snout; but in older specimens the distance between the eye and the tip of the snout grows distinctly longer, though it never exceeds $^{5}/_{4}$ of the least breadth of the interorbital space. The nasal cavities — each with its pair of round nostrils set close to each other, the posterior larger than the anterior, which is slightly cucullate — lie in young Coalfish twice, in older ones nearly three times, as far from the tip of the snout as from the eye. The mouth is only slightly cleft. The jaws are of almost the same length in young Coalfish, but during growth the tip of the lower jaw advances more and more. In full-grown Coalfish there is generally no barbel under the chin, but in young specimens, and sometimes in old, here as in the Whiting, a small barbel is present (see DAY'S figure for example). The teeth in the maxillary cards are small and of almost uniform size, those in the outermost row being slightly larger than the rest. In the lower jaw they are set in two rows in front and in one behind. On the head of the vomer there are two rows, set in an obtuse angle open behind. The gill-covers are smooth, with the several bones so closely united that they apparently form a single whole; the margin is rounded and smooth. The operculum has a blunt tip, set high above the base of the pectoral fin. The gill-openings are large. A broad strip of the branchiostegal membrane of one side of the body is united to that of the other side, lying across the isthmus, but not attached to the latter. The gill-rakers are pectinal in the outer row on the first branchial arch, in the other rows more tubercular and scattered, though rather high. The tongue is smooth and white, with dark edges and broad tip.

The body, cheeks, and face, and the bases of the fin-rays are covered with fine, imbricated scales. The lateral line is almost straight, begins at the upper margin of the gill-opening, slopes slightly downward along the body, and advances along the middle of the sides of the tail.

The vent lies at a distance from the tip of the snout equal to about 36—39 % of the length of the body.

The first dorsal fin is, as usual, short and in front high with rounded corner. Its base measures about $10^{1}/_{2}$—13 % of the length of the body, and its height about $9^{1}/_{2}$—12 % thereof. It begins about half-way between the perpendiculars from the insertion of the ventral fins and from the anal aperture, at a distance from the tip of the snout measuring between about 32 % (sometimes $30^{1}/_{2}$ %) and 33 % of the length of the body. It usually contains 12 or 13 rays, the first two simple, the others branched at the tip. The second and longest dorsal fin, the base of which measures about 19—$21^{1}/_{2}$ % of the length of the body, is highest in front, sometimes even higher than the preceding fin, and very sloping. It begins in young Coalfish almost vertically above the beginning of the first anal fin, in older specimens a little farther back. It is usually made up of 20 rays, the first two simple, the others branched. The third dorsal fin resembles the second in shape, but is much shorter, its base measuring about 13 or 14 % of the length of the body, and much lower, its height being about 6 or 7 % of the length of the body. It is also composed in most cases of 20 rays, the first three of which are simple.

The first anal fin resembles the second dorsal, and the distance between it and the tip of the snout is about 42—44 % of the length of the body. The length of its base, which relatively decreases during growth, measures about 32—27 % of that of the body. It usually contains 25—27 rays, the first five simple and shorter than the sixth, which is the longest and, like the following rays, branched at the tip. The second anal fin is analogous to the third dorsal, and is generally composed of 21 or 22 rays, the first three simple and shorter than the fourth, which is longest and, like the rest, branched at the tip.

The caudal fin is deeply forked, with pointed lobes. The length of its middle rays is only slightly more than, or even equal to, the least depth of the tail.

The pectoral fins, the length of which is about 14—13 % of that of the body, are set high and obliquely pointed, but rounded at the tip. They are made up of about 20 rays, the uppermost two simple. The ventral fins are very small, their length being about

7½ or 7 % of that of the body, and pointed, with the second ray longest but only slightly longer than the first and third. Their insertion, which moves forward during growth, to a point about 16 or 19 % of the length of the body distant from the beginning of the first anal fin, thus lies eventually in front of the perpendicular from the tip of the gill-cover. The first two rays are simple.

The internal organs, of which Schagerström[a] has given a minute description, are almost like those of its congeners. The only differences are that, as in the next species, the right lobe of the liver is only slightly shorter than the left, and the pyloric appendages are also extremely numerous.

The coloration, which alters to some extent with age, is darker in old Coalfish than in young. As a rule the back and the upper part of the head are dark olive-green. This colour grows lighter downwards, the sides a little below the lateral line[b], which is white and in front almost moniliform, being yellowish gray. Still lower down the sides turn white, the belly and the under surface of the head being silver-gray or, at the very bottom, milky white. All the fins are of a plain, dark olive-gray, except the anal fins, which are white at the base, and the ventral, which are reddish white. The forehead, the snout, and the lips are black, the inside of the mouth in old specimens black, in young gray, and the tongue always white with black edges[c]. The iris is silvery, with a dark or reddish tinge.

The Coalfish is a North Atlantic species, whose true geographical range essentially coincides with that of the Cod, but must probably be regarded as of a rather more southern character. It is true that, according to Day, this fish was the only one found by Lord Mulgrave on the shores of Spitzbergen, that Captain Simonsen is said in 1872 to have observed enormous numbers of Coalfish there in Green Harbour[d], and that Captain Lindström stated to Malmgren that he had taken both Haddocks and Coalfish off the south point of Spitzbergen. But none of the numerous Swedish Expeditions to Spitzbergen or the Norwegian Arctic Expedition found a single Coalfish there. The species is probably very rare on the coast of Greenland as well, for Fabricius never observed it in person. More recently, however, it has been forwarded thence, according to Reinhardt[e], to Copenhagen Museum; and during Parry's first voyage the fry of the Coalfish were found, it is stated, on the west coast of Davis' Strait. On the other hand, the Coalfish is common from the Murman coast and Finmark, Iceland and Newfoundland, on the American coast south to Massachusetts, and on the European coast to France. There, however, according to Moreau, it grows rare south of the Loire (47° N. lat.) and is only occasionally met with in the Bay of Biscay, while on the other side of the Atlantic, according to Dekay, the extreme southern limit of its geographical range is off New York (40° N. lat.). Canestrini[f] includes the Coalfish among the Mediterranean forms on the south coast of Italy; but Giglioli[g] states that he had never seen an Italian specimen, and neither Duhamel nor Moreau give it among the Mediterranean fishes of France, nor did Steindachner find it on the coasts of the Spanish Peninsula. In Scandinavian waters the Coalfish is largest and most common on the Norwegian coast all the way to Finmark. In the north of the Cattegat the older specimens become rarer, though young Coalfish are found, in certain years at least, in fairly large numbers. Off Kullen the species is common all the year round, but only sometimes enters the Sound, according to both Nilsson and Schagerström. Schonevelde describes it from the east coast of Schleswig-Holstein, and Walbaum furnished Bloch[h] with specimens from Lübeck; but in recent times it has not been found there[i]. Farther up the Baltic it has never been met with.

The Coalfish is less voracious than the Cod, if we may judge by the fact that its food seems to consist chiefly of small fishes and crustaceans. The Capelin

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[a] Vet.-Akad. Handl. 1831, p. 149.

[b] v. Wright's figure apparently shows that in the living fish the lateral line may be of the same colour as the body, in young specimens at least.

[c] According to Collett (N. Mag. f. Naturv., l. c.) Sparre-Schneider received on behalf of Tromsö Museum a Coalfish that was quite red, like a *Sebastes*.

[d] Peterm. Geogr. Mitth. 1872, p. 463; Heuglin Reisen n. d. Nordpolarmeer 1870—71, vol. 3, p. 221.

[e] D. Vid. Selsk. Naturv. og Math. Afh., 7:de Deel, pp. 115 and 128.

[f] *Fauna d'Italia, Pesci*, p. 155.

[g] Espos. intern. di Pesca in Berlino 1880, Sez. Ital. Cat., p. 96.

[h] *Fische Deutschlands*, II, p. 166.

[i] See Möbius and Heincke, l. c.

(*Mallotus villosus*) and Herring, the fry of the Cod, and a small crustacean (*Thysanopoda inermis*), which according to Sars (Indberetning for Aaret 1874) also forms the food of the blue whale (*Balænoptera Sibbaldii*) on the coast of Finmark, seem to guide the wanderings of the Coalfish in search for food. In April it approaches the coast of Finmark, and arrives there, says Collett, in an extremely lean condition, probably after the spawning, but soon puts on flesh when it has feasted a short time on Capelin. There is tumult and disturbance at the surface of the sea when the shoals of Coalfish chase their prey, with a splashing and lashing in the water like the noise of the sharpest hailstorm. In summer the shoals assemble at the spots where the "*kril*" (*Thysanopoda inermis*) are collected by the currents. Sars[a] describes from eyesight how the Coalfish prey upon the Cod fry. "It was a regular battue, the hunt almost seeming to be pursued in common and on preconcerted lines. So far as I could judge, the plan was as follows. The Coalfish surrounded the fry on all sides, and by drawing the circle closer and closer drove them together in a dense mass, which they then proceeded by a sudden manœuvre to chase up towards the surface. The wretched victims thus found themselves attacked on both sides: underneath they had the voracious Coalfish, which in the excitement of the chase often leapt high out of the water, and above them hovered hundreds of screaming gulls, which with marvellous swiftness and unerring aim watched their time and swooped down at the spots where the Coalfish appeared, to seize their share of the prey." The Coalfish is just as eager in its pursuit of the Herring; and during the Herring-fishery in Bohuslän it has been known in its rapacity to rush up on dry land.

The difference between old and young Coalfish is not confined to the coloration, but also extends to their habits, and the fishermen of all nations have, therefore, given them a number of different names[b]. In Bohuslän the old Coalfish are known as *Sej*, *Gråsej* (Gray Coalfish), or *Gråsik*. At this age they prefer deep water with a rocky bottom, and hardly ever come close in shore. The young, which are called *Småsej* (Small Coalfish) and *Näller*, choose their haunts in the fjords and in shallow water. The whole life of this fish, however, as well as the form of its body, is a blending of the characters of the Cod and the Mackerel. Both large and small Coalfish, especially the latter, show traces of the activity of the Mackerel. In summer, among the islands, the young specimens are seldom seen at the bottom, but generally swim in mid-water, roving along the shores in large shoals, especially where there is a current, in which case they keep to the surface and often leap high above it.

In the Cattegat, according to Ekström, the Coalfish spawns in spring, at the end of March or beginning of April. In Massachusetts Bay Earll found the spawning-season to be in November and December. In a female 3 ft. 3 in. long and 23$^1/_2$ lbs. in weight he estimated the number of the eggs at about 4 million, and in another female 2 ft. 8$^1/_2$ in. long and 13 lbs. in weight, at about 2$^1/_2$ million. In Bohuslän the fry, about 60 mm. long, appear along the shores in July; and in May Malm saw a large shoal of Coalfish of the second year, about 2 dm. in length, taken off Hellevikstrand. In the stomach of one of these young specimens, which was 22 cm. long, he found 77 Herring-fry, each about 40 mm. in length. At the approach of winter the young Coalfish repair to deep water.

The old Coalfish are taken, like the Cod, with hand-lines (*dörj*) and long-lines and in gill-nets. The young specimens are caught in the seine and, in Norway, in the sack-net (*Syckenot*), a square seine which is allowed to sink, and is drawn straight up by four boats, each with a line attached to one of the four corners of the net, as soon as the shoal of Coalfish which has been observed, is over it.

The Coalfish is sometimes salted in the same way as the Cod, but is of less value when cured in this manner. It is generally dried. The young specimens are eaten fresh, or salted and consumed by the poor. The dried Coalfish which is sold under the name of Stockfish (i. e. dried on poles, *stock* = stick), is known in the north of Scandinavia as *Rotskär*, and is prepared as follows. The fish is killed and gutted, and then split along the back and belly, so far down towards the tail that only one or two vertebræ of the spine are left, at the base of the caudal fin, where the skin keeps the two halves together. It is then hung up on poles, and left there till perfectly dry, when the stockfish is ready.

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[a] Indberetning for 1866 og 1867.

[b] Hardly any fish has borne so many different names according to age and locality. Brown-Goode (l. c.) enumerates 52 different names for the Coalfish in various parts of England. In Norway, according to Nilsson, the Coalfish is called *Mort* until it is 15 cm. long, *Pale*, while its length is between about 22 and 44 cm. (i. e. in its second and third years); and does not bear the name of *Sej* until its fourth year.

To the Norwegian fisherman the Coalfish is of no small importance. According to COLLETT 2 or 3 million kgm. of dried Coalfish are annually exported from Norway, chiefly to Sweden and Finland; and in Finmark 30 or 40 thousand barrels (100 or 140 thousand bushels) of fresh Coalfish are bought up for the Russian market.

(EKSTRÖM, SMITT.)

THE POLLACK (SW. LYRTORSKEN).

GADUS POLLACHIUS.

Plate XXIV, fig. 3.

Length of the base of the first anal fin more than half the distance between this fin and the tip of the snout. Lower jaw most prominent, its length being at least about 55 % of that of the head and, as a rule, more than 14 % of that of the body. Distance between the tip of the snout and the hind extremity of the maxillary bones at most about 70 % of the length of the lower jaw, but greater than the length of the ventral fins, which is at most $^6/_5$ of the least depth of the tail or even less than it. Least depth of the tail more than 36 % of the length of the lower jaw, than 40 % of the base of the third dorsal fin or of the length of the pectoral fins, or than 85 % of the least breadth of the interorbital space. Distance between the first dorsal fin and the tip of the snout at least about 30 % of the length of the body. Length of the snout less than 62 % of that of the lower jaw, but at least about 70 %[a] of the postorbital length of the head. Length of the middle rays of the caudal fin more than $6^1/_2$ % of that of the body. Lateral line arcuate in front and of a dark colour.

R. br. 7; *D.* 11—13[b] 17[c]—21 16[d]—20; *A.* 27[e]—31 18[f]—20; *P.* 17[g]—19; *V.* 6; *C.* $x+25—29+x$; *Vert.* 53 l. 54.

Syn. *Asellus flavescens*, SCHONEV., *Ichth. Slesv. Hols.*, p. 20, No. 9, Asellus Huitingo Pollachius, WILLUGHBY, *Hist. Pisc.*, p. 167; *Gadus* No. 3, ART. *Ichth.*, *Gen.* p. 20; *Syn.*, p. 35; *Lyrbleck*, LIN., *It. Westrog*, p. 177; LYR, STRÖM, *Söndm. Beskr.*, part. I, p. 294; *Lieu*, DUH., *Tr. Pêch.*, part. II, sect. I, p. 121, tab. XX.

Gadus Pollachius, LIN., *Syst. Nat.*, ed. X, tom. I, p. 254; *Fn. Suec.*, ed. II, p. 112, OSB. (*Lerbleking*), Vet.-Akad. Handl. 1767; p. 245, tab. VII: RETZ., *Fn. Suec. Lin.*, p. 321; NILSS., *Prodr. Ichthyol. Scand.*, p. 43; FR. et V. WR., *Skand. Fisk.*, ed. I, p. 89, tab. 20; KR. (*Merlangus*), *Danm. Fiske*, vol. II, p. 123; NILSS. (*Gadus*), *Skand. Fn.*, *Fisk.* p. 562; THOMPS., *Nat. Hist. Irel.*, vol. IV, p. 183; GTHR, *Cat. Brit. Mus. Fish.*, vol. IV, p. 338; STEIND., Stzber. Akad. Wiss. Wien, Math. Naturw. Cl., Bd. LVII, I (1868), p. 706; COLL. Forh. Vid. Selsk. Christ., 1874, Tillægsh., p. 111; N. Mag. Naturv. Christ., Bd. 29 (1884) p. 82; WINTH., Naturh. Tidskr. Kbhvn, ser. III, vol. XII, p. 30; MOR. (*Merlangus*), *Hist. Nat.*, *Poiss. Fr.*, tom. III, p. 241; DAY, (*Gadus*), *Fish. Gt. Brit.*, *Irel.*, vol. I, p. 296, tab. LXXXIII, fig. 2; MÖB., HCKE, *Fisch. Osts.*, p. 80; STORM, Norsk. Vid. Selsk. Skr. (Trondhj.) 1883, p. 34; LILLJ., *Sv.*, *Norg. Fn.*, *Fisk.*, vol. II, p. 92.

Gadus lycostomus, FABER, Tidskr. Naturv. Kbhvn, vol. 5 (1828), pp. 215 et 251 (vide KRØYER, l. c.).

Pollachius Linnéi, MALM, *Gbgs*, *Boh. Fn.*, p. 487.

The Pollack, according to MOREAU, sometimes attains a length of as much as 13 dm.; but it is generally smaller than the preceding species, and the largest Pollacks taken in Scandinavian waters are seldom more than between 45 and 60 cm. long. The body, which is deepest at the vent, tapers from this point both forward and backward. The back is moderately convex, and is furnished in old Pollacks with a small longitudinal depression or groove just in front of the first dorsal fin. The belly is rounded in front of the vent, but somewhat carinated behind it. The sides are moderately convex, the greatest breadth (thickness) being about half the depth. In old Pollacks the greatest depth of the body is 22—25 % of its length, in young ones about 19 or 20 %. The head, the length of which is about 25 or 26 % of that of the body, is of a handsome, cuneiform shape, with depressed forehead, sloping quite evenly to the broad, rounded tip of the snout, which is quite thin and low. The sides of the head are flat, and almost parallel right out to the snout.

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[a] Usually 72—78 %.

[b] Sometimes 14, according to KRØYER.

[c] ,, 15, ,, ,, ,,

[d] ,, 15, ,, ,, DAY.

[e] ,, 23.

[f] ,, 16, ,, ,, ,,

[g] ,, 16, ,, ,, KROYER.

The lower jaw is always distinctly longer than the upper, somewhat pointed, and is the extreme tip of the wedge formed by the head when the jaws are closed. The length of each branch of the lower jaw is between about 14 % (in young specimens sometimes slightly less) and $15^{1}/_{2}$ % of the length of the body or about 57—60 % of that of the head. The upper jaw is not protruded when the mouth is opened; and when the mouth is closed, the maxillary bones are almost entirely concealed by the labial fold that unites the margin of the snout to the suborbital ring. The hind extremity of the maxillary bones extends to the perpendicular from the anterior margin of the eye, and lies at a distance from the tip of the snout equal to about 10 % of the length of the body or 65—70 % of that of the lower jaw.

Fine, pointed teeth of uniform size are set in a card on the intermaxillary bones and in a simple or (in front) double row in the lower jaw and on the head of the vomer. The tongue is of an oblong, triangular shape, rather soft, and with long, free tip. The branchiostegal membranes of both sides of the body are united inferiorly into a free fold, so broad that the margin at the middle extends almost to a line with the hind extremity of the lower jaw.

The eyes are round, and measure $^{1}/_{4}$—$^{1}/_{5}$ of the length of the head, according to the age of the specimen. Their position is such that the line drawn along the middle of the body to the tip of the upper jaw passes somewhat above the centre of the pupil, which lies a little in front of the middle of the head. The length of the snout is between about 75 % (sometimes 70 %) and 78 % of the postorbital length of the head. The distance between the eyes is about 65—75 % of the length of the snout, and in young Pollacks is less, in old greater, than the longitudinal diameter of the eyes. The nostrils are set in the last third of the length of the snout. The hind margin of the anterior nostril on each side is raised into a cucullate dermal flap, which may be dropped forward like a lid over the small aperture. The posterior nostril is larger, but without any elevation of the margin.

The whole head, with the exception of the jaws, is covered with scales, though these scales are smaller than those of the body. In old and middle-aged Pollacks the length of the head is about 25 or 26 % of that of the body, in very small specimens somewhat greater.

The body is entirely covered with small, thin, and imbricated scales, set very densely and firmly attached to the skin. These scales are, however, indistinct until the skin is partly dry, or the slime has been removed. The lateral line is of exactly the same structure as in the Whiting, and forms the same upward curve from behind, below the second dorsal fin.

The anal aperture is situated a little behind the end of the first third of the length of the body, below the last third of the pectoral fins, or somewhat behind the perpendicular from the beginning of the first dorsal fin.

The top of the insertion of the pectoral fins lies half-way up the body. These fins are rounded at the tip and contain 2 simple and (generally) 17 branched rays. The whole base is covered with scales. The ventral fins are still smaller than in the Coalfish, their length being about $6^{1}/_{2}$ % of that of the body, and varying to such an extent that in young Pollacks it is about half, in old considerably less than half, of the distance between their insertion and the beginning of the anal fin, a distance which increases with age from about 13 or 12 % to nearly 16 % of the length of the body. They are set somewhat in front of the pectoral fins, and are made up, as usual, of 6 rays, the first two simple or the second indistinctly cleft, the others branched at the tip. None of these rays has a long, free tip, and the third ray is the longest.

The three dorsal fins are of normal structure, rather thick, and covered with scales. The first begins at a distance from the tip of the snout measuring 33 or 34 % of the length of the body, and the length of its base is about 9—11 % of the same length. The first two or three rays are simple, but soft at the tip, and the third or fourth ray is the longest, its length in young Pollacks being usually rather more, in old rather less, than the postorbital length of the head. The fin-membrane is entirely covered with rather fine scales out to the margin. The second dorsal fin begins at a distance from the tip of the snout equal to about 42—47 % of the length of the body, and its base measures about $17^{1}/_{2}$—$20^{1}/_{2}$ of the same length. It is generally somewhat lower than the first dorsal fin, and only the first ray is simple. The second and third rays are the longest. The distance between the beginning of the third dorsal fin and the tip of the snout is about 66—69 % of the length of the body, and the length of its base about 13 or 14 % thereof. The first three or four rays are simple, and the third, fourth, and fifth the longest, measuring about 10—7 % of the length of the body.

The membrane of the anal fins is also covered with scales. The first anal fin begins at a distance from the tip of the snout of between about 36 and nearly 40 % of the length of the body, and its base measures about 30—$31^{1}/_{2}$ % thereof. The first six rays are simple, the seventh and eighth the longest, in young Pollacks about equal in length to the distance between this fin and the ventral fins, in old much less, sometimes no more than $11^{1}/_{2}$ % of the length of the body. The second anal fin is as usual analogous to the third dorsal both in length and in height. Its first four rays are simple, and the fifth ray is the longest.

The caudal fin is perfectly truncate at the margin when expanded, but at other times slightly forked. The length of its middle rays is about 7 or $7^{1}/_{2}$ % of that of the body, and always greater than the least depth of the tail, which measures about 78—90 % of the former length. This fin is also entirely covered with fine scales.

Though the coloration of the Pollack is highly variable, it is still to some extent characteristic. The back is of a dark, olive-brown colour, which is sharply set off by a distinct line of demarcation from the silver-gray or aluminium colour of the belly and sides. This line runs quite straight, as though it were drawn with a ruler, from the upper corner of the gill-opening to the bottom of the upper third of the base of the caudal fin. The ground-colour is diversified by a coarse-meshed, irregular network of a dark, flame-yellow colour, which varies in different specimens, being faint or distinct, continuous or replaced by spots. As a rule this network appears in middle-aged specimens as shown in the figure. In young specimens it is much lighter and more distinct, while in older ones only traces of it are visible, and after death it disappears altogether. All the fins, except the ventral, are of the brown colour of the back, and the dorsal fins are adorned with more or less distinct flame-yellow stripes or spots. The ventral fins, especially in young Pollacks, are of a bright yellowish colour. The lateral line is greenish. The iris is silvery, with a fairly broad, yellowish-brown ring surrounding a very narrow, lighter ring which bounds the pupil.

The vent lies at about the middle of the abdominal cavity. The peritoneum is silvery. The air-bladder is very long, longer than the abdominal cavity, its hind extremity penetrating into the passage formed by the downward processes (hæmal arches) of the caudal vertebræ. With these exceptions there is no difference worthy of mention between the internal organs of this species and those of the preceding one.

The geographical range of the Pollack is still more restricted than that of the Coalfish. It belongs to the north-east of the Atlantic, and hardly penetrates into the Arctic Ocean, though solitary specimens are sometimes taken even in Varanger Fjord and Öx Fjord in the north of Finmark. COLLETT places the northern boundary of its true habitat in the neighbourhood of Trondhjem. To the South, however, there is better evidence of its occurrence than of that of the Coalfish on the coast of the Spanish Peninsula, where STEINDACHNER found it to be common off Galicia, but rarer on the coast of Portugal. On the English coast, according to BUCKLAND[a], the Pollack is "one of the commonest fish, and is found on all our coasts where the nature of the ground is suitable to its habits. Its haunts are upon rocky ground, and at no great distance from the land." This statement also applies to every rocky part of the west coast of France; but the Pollack has been observed even on the sandy coast of Holland, though, like the Coalfish, only on rare occasions[b].

On the west coast of Sweden the Pollack is known by several names, e. g. *Blanksej*, *Sejlyra*, *Plank*, *Lyrbleck*, *Lerbleking* etc., and in Norway it is called *Lyr* and *Lyrtorsk*. It is fairly common on the south coast of Norway as well as in Bohuslän, in part of Halland, and off Kullen. It is taken there plentifully, especially during the summer months. It is "spread over all the Danish waters," according to WINTHER; and is sold in the market-place of Kiel under the name of "Spanish Salmon," according to Möbius and Heincke, who place the boundary of its extension in the Baltic off the coast of Mecklenburg. A solitary specimen of the Pollack, 23 cm. in length, is stated by Nilsson to have been taken in the Baltic off Esperöd, north of Cimrishamn, near Kivik[a]. This specimen was taken in an Eel-pot, on the 25th of September. With this exception the Pollack is unknown on the Baltic coast of Sweden and off Bornholm.

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[a] *Nat. Hist. Brit. Fish.*, p. 190.

[b] See VAN BEMMELEN in HERKLOTS, *Bouwstoffen voor eene Fauna van Nederland*, Deel. III, p. 352.

The largest specimens are taken in summer, when the Pollack enters the island-belt of Bohuslän in shoals, and pursues the fry of other fishes, especially of the Herring (*sillmör*). Among these it makes great havoc, ascending right up to the surface to seize them. During these assaults of the Pollack one may continually see whole bodies of Herring-fry throw themselves out of the water to escape their enemy, who in his turn follows their example to make sure of his prey. From the disturbance and the noise thus caused at the surface, the fisherman easily remarks the approach of the Pollack, and is never disappointed of a good haul when the seine is shot on these occasions.

As long as the Herring-fry remain on the coast, the Pollack stays there too; but when they depart, it speedily retires into deeper water. Young Pollacks are, however, found along the shores periodically, at longer or shorter intervals, all the autumn and even at the beginning of winter; but these specimens are never taken in so large numbers as the older ones during the summer months.

The Pollack seems to be the least voracious of its congeners. Its food is composed of small marine animals and especially of Herring-fry. In the island-belt of Bohuslän it is at least exceptional that a Pollack should be taken on any of the lines there in use. It has long been known, however, that the Pollack is not always deficient in the voracity that characterizes the Cods in general, but sometimes freely takes a hook. Thus, the Pollack is taken at certain spots and in certain seasons, both on the French[b] and English[c] coasts, with a kind of running-line from a row-boat or a sailing boat. A bait of Sand-eels is best, though artificial bait may also be used.

The spawning-season of the Pollack is said, like that of the Whiting, to occur in winter.

Among all the common species of the genus the Pollack is the least esteemed in Scandinavia, no great value being set upon its flesh, which is undeniably rather dry and, like that of the Coalfish, requires careful preparation to render it palatable. Still it is eaten everywhere where this fish occurs, partly fresh, and partly salted or dried.

The only engine in which Pollacks are taken in any quantity on the coast of Bohuslän, is the seine. The fishery is not equally productive every year, however, this depending on the greater number of Pollacks that enter the inlets in certain years, from the causes described above. Instances are known of the catch of a hundred large Pollacks at a single haul of a very small seine, and half a boat-load has often been taken in a Mackerel-seine. Only slight attention is paid, however, to this fishery, and it is pursued only when time admits.

(Fries, Smitt.)

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[a] *Esperod* is a common place-name in Scania. One place of this name lies near Höganäs. Nilsson evidently refers to the one adopted in the text, but a confusion is perhaps not impossible.

[b] See Duhamel, l. c., p. 126, pl. XXI, fig. 3.

[c] Day, l. c., p. 298.

NORWEGIAN WHITING POLLACK (SW. HVITLINGLYRA.)

GADUS ESMARKII.

Pl. XXVII, A, fig. 1, and Fig. 122.

Length of the base of the first anal fin more than half the distance between this fin and the tip of the snout. Lower jaw most prominent, its length being at least about 52 % of that of the head, but less than 14 % of that of the body. Distance between the tip of the snout and the hind extremity of the maxillary bones at most about 82 %[a] *of the length of the lower jaw, and in adult specimens less than the length of the ventral fins, which is at least twice the least depth of the tail. Least depth of the tail less than 35 % of the length of the lower jaw, than 25 % of the base of the third dorsal fin, or than 27 % of the length of the pectoral fins. Distance between the first dorsal fin and the tip of the snout at most about 28 % of the length of the body. Length of the snout less than 62 (56?) % of that of the lower jaw. Length of the middle rays of the caudal fin more than 6½ % of that of the body. Lateral line dark (though not very distinct) and anteriorly slightly curved.*

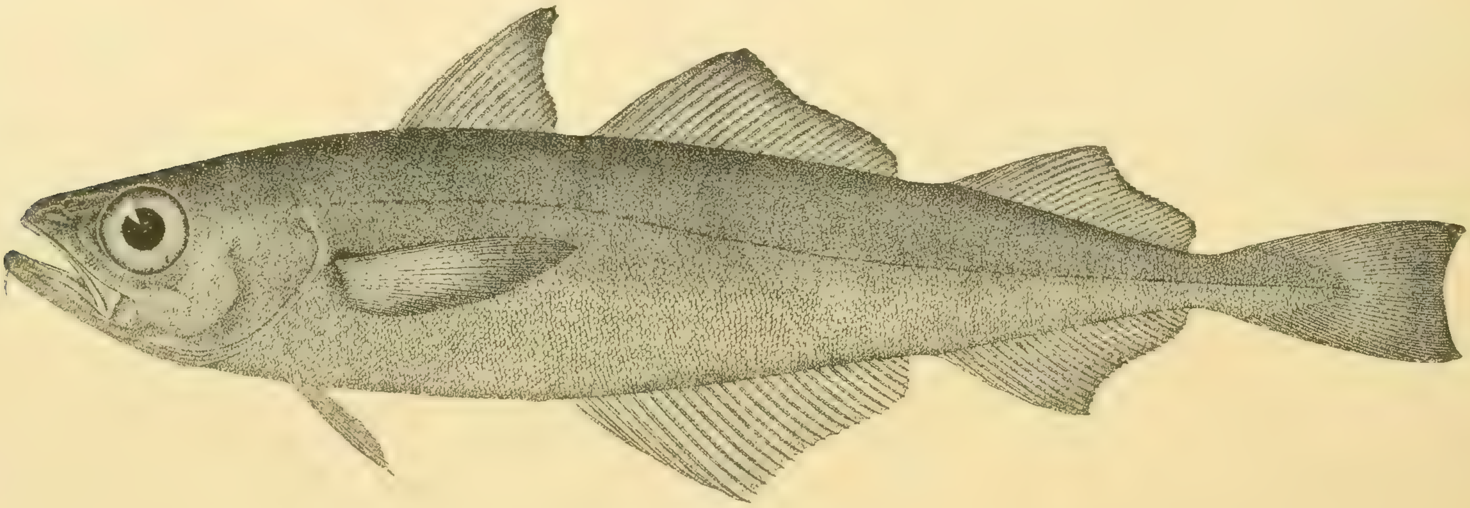

Fig. 122. *Gadus Esmarkii*, natural size. From Strömstad Fjord, Sept., 1888. C. A. HANSSON.

R. br. 7; *D.* 14—16 | 23[b]—26 | 24[b]—27; *A.* 26—30 | 24—38; *P.* 19; *V.* 6; *C. r*+20—24+*r*; *Vert.* 52.

Syn. *Gadus minutus*, ESM. (nec LIN.), Forh. Skand. Naturf. M. Christ. 1844, p. 231; MALM (*Boreogadus*), *Gbgs, Boh. Fn*, p. 486. *Gadus Esmarkii*, NILSS., *Skand. Fn., Fisk.*, p. 565; GTHR, *Cat. Brit. Mus., Fish.*, vol. IV, p. 337; COLL., Forh. Vid. Selsk. Christ. 1874, Tillægsh., p. 109; N. Mag. Naturv. Christ., Bd 29 (1884), p. 81; CEDERSTR., Öfvers. Vet.-Akad. Förh. 1876, No. 4, p. 66; STORM, Norsk. Vid. Selsk. Skr. (Trondhj.) 1883, p. 34; LILLJ., *Sv., Norg. Fn., Fisk.*, vol. 2, p. 98.

Gadus Esmarkii (Sw. *hvitlinglyra*[c] = Whiting Pollack), like the Poor Cod, is one of the smallest Scandinavian species of this genus, and hardly attains the same size as the latter. Our largest specimen from Bohuslän is a little under 19 cm. in length, but COLLETT gives 240 mm. as the maximum length of this species within his experience. The form of the body is more elongated and thinner than in the Pollack or the Coalfish, the greatest depth varying between about 17 and 19½ % of the length of the body, and the greatest thickness between 9 and 10 % of the latter. The least depth of the body, just in front of the caudal fin, is hardly more than 4 % (at most 4½ %) of its length. The dorsal and ventral profiles are fairly regular, but the latter is more arched in front, and at the beginning of the third dorsal and second anal fins there is a break, behind which, though it may be indistinct, the depth of the tail decreases more rapidly.

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[a] Never quite so much, according to our investigations.

[b] Sometimes 22, according to LILLJEBORG.

[c] CEDERSTRÖM, l. c.

The head is comparatively smaller than in either of the two preceding species, and its relative length, contrary to the general rule in most of the species of this genus, seems to decrease with age, varying between about $24^1/_2$ and $22^3/_4$ % of that of the body. The eyes, on the other hand, are large; and their longitudinal diameter, as in the Poor Cod, is distinctly greater in young specimens than the length of the snout, and in old specimens at least equal to it. Their size varies considerably in different individuals. Their diameter varies with age between about $8^1/_2$ and $6^1/_2$ % of the length of the body, while the length of the snout varies still more individually between about 6 and 7 % thereof. The nostrils are situated as in the Pollack, but are somewhat larger. The mouth is also larger, the hind extremity of the maxillary bones extending farther back below the eyes, for about a third of the length of the latter, while the length of the lower jaw is greater than in the Coalfish, but less than in the Pollack[a]. This is due to the fact that the lower jaw does not project so far as in the latter species. A small barbel is suspended from the chin. The mouth is turned upwards at an angle of about 30°. The jaw-teeth are set, as in all the small Cods, in a very narrow card (2—4 rows) in front, and in a single row behind; and are small and of fairly uniform size, as in the other species of the Coalfish-group. On the head of the vomer they are set in a curved, obtuse-angled, transverse row. The hind margin of the gill-cover is somewhat elongated just above the insertion of the pectoral fin, but the postorbital part of the head as a whole is shorter than in either of the two preceding species, its length varying with age between about 10 and 9 % of that of the body[b]. The branchiostegal membranes are united underneath into a free, continuous, dermal fold, which at the middle extends a little behind the posterior extremities of the branches of the lower jaw.

The paired fins are pointed and longer than in the two preceding species of this group. The two uppermost rays of the pectoral fins are simple, the first being about $^2/_3$ as long as the second, which does not quite extend to the tip of the fin. The 3rd—6th rays are the longest. The tip of these fins always extends behind the vent, their length varying with age between about 16 and nearly 19 % of that of the body. The first two rays of the ventral fins are also simple, and the second ray is the longest in the whole fin, though only slightly longer than the first. The length of these fins varies with age between about 11 and 13 % of that of the body, and their insertions lie distinctly in front of those of the pectoral fins.

The unpaired fins are well separated, and are distinguished from those of the other species of this group partly by the more forward position of the dorsal fins, and partly by the greater length of the third dorsal and the second anal fins.

The first dorsal fin is the highest, and when erected almost resembles a right-angled triangle, the base of which is about $10^1/_2$—$11^1/_2$ % of the length of the body, and which begins at a distance from the tip of the snout of about 28—27 % (sometimes 26 %) thereof. The first two rays are simple, the others (with the exception, according to the general rule, of the last of all) finely branched at the tip. The third ray is the longest, its length being about 13—15 % of that of the body. The second dorsal fin is more elongated, and its first two rays are also simple, the third ray being generally the longest, though only slightly longer than the second or fourth, and slightly shorter than the longest ray of the preceding fin. The distance between this fin and the tip of the snout is about $38^1/_2$—41 %, and the length of its base about 20—$22^1/_2$ %, of the length of the body. The third dorsal fin begins at a distance from the tip of the snout measuring about 62—66 % of the length of the body, and the length of its base is between 18 and about 17 % of the same length. The first three rays are simple, and the fourth, fifth, or sixth the longest, its length being about 10—$10^1/_2$ % of that of the body.

The distance between the beginning of the first anal fin and the tip of the snout is between about 38 (sometimes $36^1/_2$) and 41 % of the length of the body, and its base measures about $27^1/_2$—$22^1/_2$ % of the latter. The first three (in young specimens the first four or five) rays are simple, and the fifth ray the longest, its length being about 13—$11^1/_2$ % of that of the body. The second anal fin is shorter in young specimens than the third dorsal, but in older ones the only differences between them are that the former is somewhat lower and situated rather farther back. The first three or four rays are simple.

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[a] The distance between the tip of the snout and the hind extremity of the maxillary bones varies with age between about 11 and $9^1/_2$ % of the length of the body, and the length of the lower jaw between about $13^1/_2$ and 12 % of the latter.

[b] In the two preceding species we have never found the postorbital length of the head less than $10^1/_2$ % of the length of the body.

The caudal fin is more forked than in the Pollack, the hind margin being concave even when the fin is expanded to its full breadth. The middle rays are, however, comparatively of the same length as in the Pollack, their length being at least $^1/_6$ greater than the least breadth of the interorbital space, and the least depth of the tail never rising as high as $^2/_3$ of the length of these rays.

The scales are thin and small as in most of the Cods, but somewhat larger than in the Pollack, imbricated and striated. They cover the whole body, and small scales occur even on the snout and far out over the caudal fin. The lateral line forms a slight upward curve from behind at about the tip of the pectoral fins.

The abdominal cavity extends behind the beginning of the first anal fin for about a third of the length of this fin. The stomach does not extend back to the vent. The pyloric appendages are well-developed, but comparatively few. The liver consists of one lobe, the right and — so far as we could discover in rather decomposed specimens — the left lobes are wanting. The peritoneum is of a lustrous black.

In specimens preserved in spirits the colour of this species is the same as that of young specimens of the Pollack in the same condition, though a little darker olive brown on the back and lighter aluminium colour on the sides and the belly. The dorsal and caudal fins are dark brownish at the margin. A black spot marks the root of the pectoral fins and the upper part of the axil. We have never seen the species alive, but our coloured figure (Pl. XXVII, A, fig. 1) will give a pretty good idea of a fresh specimen, as it appeared on its arrival at the Royal Museum, three days after its capture by Mr. C. A. HANSSON, off Strömstad, on the 9th of December, 1890.

Gadus Esmarkii was first discovered in Christiania Fjord and seems to find a favourite haunt in this fjord, where, according to COLLETT, it is plentiful and taken daily in large numbers during the autumn and winter months, in deep water with a clayey bottom. It generally occurs in shoals, together with the Whiting. In January and February COLLETT found gravid females of this species. In autumn he found young specimens at least 40 mm. long in quantities among the netted Sprats. In the stomach of these specimens as well as in older ones he often found nothing but White Gobies (*Aphya minuta*), which thus seem to be the chief food of *Gadus Esmarkii.* STORM found this species sparingly represented among other small Cods in Trondhjem Fjord. Farther north it has never been found. LÜTKEN[a] received specimens from the Faroe Islands, but in the Shetland Islands and on the shores of Great Britain it is as yet unknown.

The Royal Museum has received through Mr. C. A. HANSSON several specimens, taken at a depth of about 30 fathoms, from Bohuslän, but only from the immediate neighbourhood of Christiania Fjord, or from Strömstad Fjord, Dynekil, and Säcke Fjord.

Gadus Esmarkii is thus no rare species in Scandinavia, but seems to be confined to certain localities; and its insignificant size debars it from possessing any considerable value in an economical respect.

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[a] Vid. Meddel. Naturh. For. Kbhvn, 1881, p. 253.

THE POUTASSOU (SW. KOLMULEN).

GADUS POUTASSOU.

Fig. 123.

Length of the base of the first anal fin only slightly less or even greater than the distance between this fin and the tip of the snout. Length of the base of the first dorsal fin less than 25 (23?) %, and that of the base of the second dorsal fin less than 33 (30?) %, of the length of the base of the first anal fin. Lower jaw most prominent, its length being at least 54 % of that of the head, but less than 14 % of that of the body. Distance between the tip of the snout and the hind extremity of the maxillary bones at most about 81 %[a] *of the length of the lower jaw, but greater than the length of the ventral fins, which is less than twice the least depth of the tail. Least depth of the tail more than 25 (29?) % of the base of the third dorsal fin, or than 27 (28?) % of the length of the pectoral fins. Distance between the first dorsal fin and the tip of the snout at least about 33 % of the length of the body. Length of the snout less than 60 % of that of the lower jaw. Course of the lateral line parallel to the dorsal profile, without any perceptible break.*

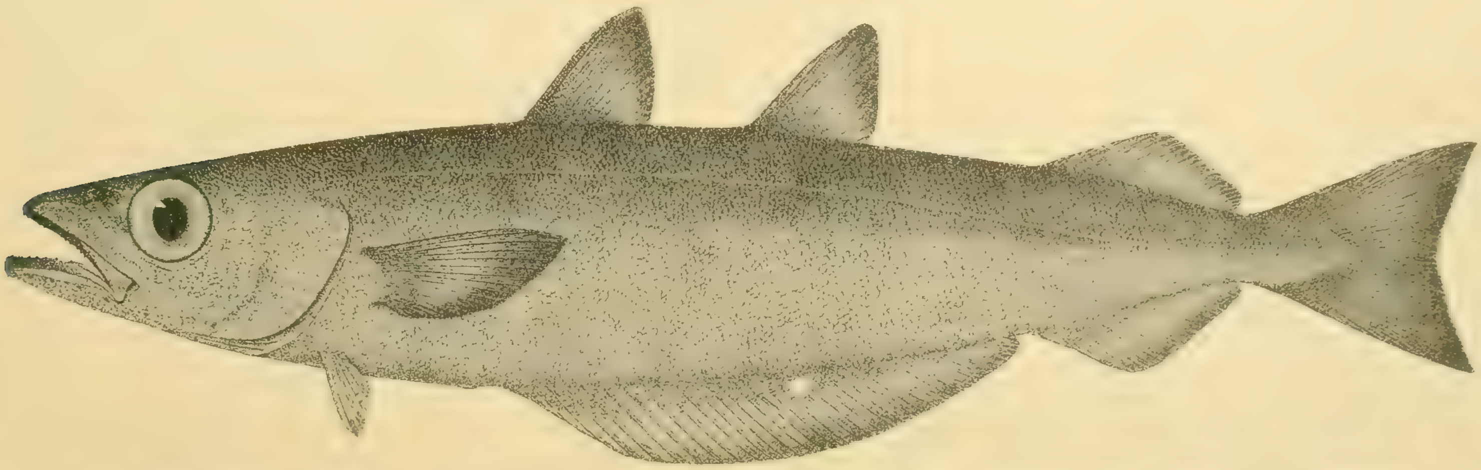

Fig. 123. *Gadus poutassou*, 1/2 of the natural size. Dynekil (Strömstad), the 10th of February, 1890. C. A. Hansson.

R. br. 7; *D.* 12–13|12—14|21—24; *A.* 34—39[b]|23—25[c]; *P.* 20; *V.* 6; *C.* x + 24 — 26 + x; *Vert.* 58.

Syn. *Gadus merlangus*, Risso, *Ichthyol. Nice*, p. 115.

Merlangus poutassou, Risso, *Eur. Mér.*, tom. III, p. 227; Düb., Kor., (*potassou*), Vet.-Akad. Handl. 1844, p. 88; Nilss. (*Gadus poutassou*), *Skand. Fn., Fisk.*, p. 556; Gthr. *Cat. Brit. Mus., Fish.*, vol. IV, p. 338; Couch, *Hist. Fish. Brit. Isl.*, vol. III, p. 77, tab. CXLI; Steind., Stzber. Akad. Wiss. Wien, Math. Naturw. Cl. LVII, i, (1868), p. 705; Coll., Forh. Vid. Selsk. Christ. 1874, Tillægsh., p. 110; N. Mag. Naturv. Christ., Bd. 29 (1884), p. 82; Malm (*Boreogadus*), *Gbgs. Boh. Fn.*, p. 486; Gigl. (*Gadus*), Espoz. Intern. Pesc. Berlino 1880, Sez. Ital., Cat., p. 96; Mor. (*Merlangus*), *Hist. Nat. Poiss. Fr.*, tom. III, p. 245; Day (*Gadus*), *Fish. Gt. Brit., Irel.*, vol. I, p. 292, tab. LXXXIII, fig. 1; Apostolides (*Merlangus*), *Pêche en Grèce* (Athen 1883), p. 29; Vinciguerra, Ann. Mus. Civ. Stor. Nat. Genova, vol. XVIII (1882–83), p. 550, tav. II, figg. 1—2; Storm (*Gadus*), N. Vid. Selsk. Skr. 1883 (Trondhj.), p. 33; Lillj., *Sv., Norg. Fn., Fisk.*, vol. II, p. 112.

Merlangus vernalis, Risso, *Eur. Mér.*, III, p. 228 (vide Mor., Vincig., Apostol.).

Merlangus albus, Yarr., *Brit. Fish.*, ed. 2, vol. II, p. 247; Düb., Öfvers. Vet.-Akad. Förh. 1844, p. 111; Forh. Skand. Naturf. Möde, Christ. 1844, p. 224.

Merlangus communis, Costa, *Fn. Regn. Nap., Pesc.*, Malacott. Sottobr., p. 7.

Gadus melanostomus Nilss., l. c.; Olss., Lunds Univ. Arsskr., tom. VIII (1871), p. 8.

The Poutassou is known in Scandinavia as *kolmulen*, *kolmulehvitlingen* (Nilsson), *kolmunnen* (Lilljeborg), in Christiania Fjord as *Spær* or, on account of its large eyes, like the preceding species, *Öien-paal*, and in Trondhjem Fjord *Blågunnar*. Even externally, in the shortness of the anterior dorsal fins, the great distance of these fins from each other and from the third dorsal fin, and the great length of the first anal fin, it differs so considerably from the other species of the genus that it seems worthy of the rank of a distinct subgenus. In the internal organs we have above remarked the peculiarity that the Poutassou has no pyloric appendages, to which we may add that, like the preceding species, it has only one lobe in the liver. Still, the external differences are not so great as to find expression in the formula of the fin-rays; and as to the comparative significance of the internal differences, *Gadus Esmarkii* forms a distinct link between the Poutassou and the other species of the genus, at least in the reduction of the liver.

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[a] Never more than 81 1/2 in the specimens we have examined.

[b] Sometimes 41, according to Lilljeborg.

[c] „ 27, „ „ „

„ 30, „ „ Risso and Moreau.

The body of the Poutassou is rather elongated, the greatest depth of the body in young specimens about 1 dm. long being sometimes only 13 or 14 % of its length, while in gravid females about 4 dm. long it may be as much as 19 % thereof. The greatest thickness of the body is about 9 or 10 % of its length. The back is almost abruptly rounded at the top. The sides of the body are flat, and converge towards the ventral margin, which however is flat. The least depth of the body increases with age from about $4^{1}/_{3}$ to $5^{1}/_{3}$ % of its length. The relation of the anterior parts of the dorsal and ventral profiles to each other varies according to the degree of tension of the dorsal muscles, in this species as in the preceding one. Sometimes, when the dorsal muscles are strongly contracted, the dorsal profile in front of the first dorsal fin runs almost straight out to the tip of the snout, while the ventral profile is arched upwards, and the cleft of the mouth also turned more sharply upwards than at other times. Sometimes, on the other hand, the dorsal profile curves slowly, but uniformly, downwards to the very tip of the snout.

The length of the head varies between about 24 and 23 % of that of the body, and the longitudinal diameter of the eyes, which are rather large, is about $^{1}/_{4}$ (26—24 %) of the former length. The position of the eyes is such that the length of the snout, which increases even relatively with age, measures about 29—33 % of that of the head, while the postorbital length of the head, which relatively decreases during growth, measures about 46—40 % of the total length thereof. The nostrils lie as in the preceding species. The maxillary bones resemble those of *Gadus Esmarkii*, extending back below the eyes in this species, too, for about a third of the length of the latter; and the distance between the tip of the snout and the hind extremity of the maxillary bones varies between about 11 and $10^{1}/_{2}$ % of the length of the body, 80 (sometimes 76) and $81^{1}/_{3}$ % of the length of the lower jaw, or (individually) about 41 and 46 % of the length of the head. The lower jaw projects only slightly, and rises at an angle of about 30°. Its length is about $13^{1}/_{2}$—13 % of that of the body or 57—56 % (sometimes 54 %) of that of the head. On the intermaxillary bones we find an outer row of large teeth and an inner row of extremely small ones. The under-jaw contains only one row, answering to the larger row on the intermaxillary bones. On each side of the crescent-shaped head of the vomer there are 1—3 teeth, equal in size to the teeth of the lower jaw; and sometimes, it is said, we may find one or two teeth between these teeth or groups of teeth. All the teeth are sharply pointed and recurved. The opercula are elongated into a short flap that ends just above the insertion of the pectoral fins. The branchiostegal membranes are as usual united to each other. The tongue is fleshy and pointed, with free tip.

The pectoral fins are obliquely pointed, and longer than in the Coalfish and Pollack, but shorter than in *Gadus Esmarkii*, their length being about 14 or 15 % of that of the body. The uppermost two rays are simple, the fourth ray the longest. The ventral fins are slightly longer than in the Coalfish, their length being about 8 % of that of the body, but the first two, simple rays are elongated into free, though not very long tips. The second ray is the longest. These fins are set just in front of the perpendicular from the insertion of the pectoral fins, at a distance from the beginning of the anal fin which increases with age from about 10 to 13 % of the length of the body. The distance between these fins and the tip of the snout, even in young specimens, is slightly less than the length of the head.

The first and second dorsal fins are more or less nearly right-angled triangles with the shortest side as base. The first begins at a distance from the tip of the snout measuring about 33 or 34 % of the length of the body, and the length of its base is about 7—$8^{1}/_{2}$ % of the latter. The first two or three rays are simple, and the second ray, sometimes the first, is the longest, its length being about $12^{1}/_{2}$—$10^{1}/_{2}$ % of that of the body. The distance between the beginning of the second dorsal fin and the tip of the snout is about $45^{1}/_{2}$—50 % of the length of the body, and the base of this fin measures about $9^{1}/_{2}$ or 9 % of the same length. In most cases only the first ray is simple, but sometimes the second ray as well, and the latter is the longest ray in the fin, its length being about $11^{1}/_{2}$ % of that of the body. The third dorsal fin, which begins at a distance from the tip of the snout measuring between 66 and 74 % of the length of the body, resembles an obtuse-angled triangle with the longest side at the base, the length of this side being about 15—13 % of that of the body. The first three or four rays, in young specimens the first eight, are simple, and the fourth is the longest, measuring about $8^{1}/_{2}$—$7^{1}/_{2}$ % of the length of the body.

The first anal fin begins at a distance from the tip of the snout equal to about 33—35 % of the length of the body, thus almost in a line with the first dorsal fin or even a little in front of it, and extends very nearly back to the beginning of the second anal fin, its length being about 31—$36^{1}/_{2}$ % of that of the body. The first four or five rays are simple, and the fifth ray is generally the longest, though its length is only about 7—10 % of that of the body. The fin is also of fairly uniform height, becoming only gradually lower behind. The second anal fin almost exactly corresponds in position and form to the third dorsal, but is somewhat longer, its length being about $17^{1}/_{2}$—$15^{1}/_{2}$ % of that of the body.

The caudal fin is deeply forked. The length of its middle rays is about 7—$5^{1}/_{2}$ % of that of the body.

The most important characteristics of the internal organs have already been noticed above. The abdominal cavity extends back to a line with the end of the second dorsal fin or even with that of the first anal fin. The peritoneum is of a lustrous black.

The covering of scales resembles that of *Gadus Esmarkii.* The scales of the body are fairly large, especially below the lateral line. Above this line about 12 scales may be counted in an oblique row from the anterior dorsal fins and from the beginning of the third dorsal fin. The head is also thickly covered with scales, and small scales clothe the snout out to the very tip. All the vertical fins are also covered with scales, at the base at least; but how far this scaly covering extends, is as yet unknown. The Poutassou has some of the characters of the true deep-sea fishes, not only in the large size of the eyes but also in the softness of the body and the looseness of the skin. The fins are covered with a thick skin at the base, but on their outer parts, as v. Düben and Koren have already remarked, the membrane is "more fragile than in the kindred species, which accounts for the fact that the fins are seldom found perfect and entire."

The coloration reminds us of that of the Herring. From the bluish gray back it grows lighter and lighter down the sides, becoming silvery and finally milk-white on the belly. The skin is finely punctated everywhere with small, round, blackish brown spots of pigment, thickest in the region of the pectoral fins, where, in the axil of the fin, they leave a trace of the black spot which we have seen in several of the preceding species. It is the black colour of the pharynx, the root of the tongue, and the inner surface of the opercula that has given the Poutassou its Swedish name (*kolmulen* = Coal-mouth).

The Poutassou, like *Gadus Esmarkii*, is one of Esmark's discoveries in the Scandinavian fauna; but almost simultaneously with his discovery of it in Christiania Fjord (1843) it was also found by v. Düben and Koren off Bergen, where it had long been known to the fishermen. It was originally described, however, though but little known to science, as a Mediterranean species. In this locality it was taken in quantities off Nice, and in spring the fry were seen in large shoals at the surface of the sea. It has sometimes appeared in the same way on the English coast. "In June, 1861," says Dunn as quoted by Day, "our bays were full of the young of this species. In 1871, if possible, they were in greater quantities, some shoals covering acres of sea-water, these leaping over each other in hungry haste to devour the young herrings, which were plentiful in the sea." Steindachner found the Poutassou off Barcelona, Giglioli includes it, as a rare species, among the fishes of Italy, and, according to Apostolides, it is common on the coast of Greece. The geographical range of the Poutassou thus seems essentially to coincide with that of the Blue-mouth (*Scorpæna dactyloptera*); and this similarity also extends to their bathymetric ranges.

On the coast of Scandinavia the Poutassou goes as far north as Norwegian Finmark. From this region the Royal Museum received from Mr. F. Bull in 1850 a specimen 2 dm. long, and according to Collett the Museum of Christiania also possesses young specimens from Öx Fjord, a little south of Hammerfest (70° 13′ N.).

So far north, however, the Poutassou does not seem to be common, though it is so in Trondhjem Fjord, according to STORM, as well as in the south of Norway. According to v. DÜBEN and KOREN it is taken with hook and line all the year round off Bergen, in 80—100 fathoms of water. In Christiania it is daily exposed for sale, according to COLLETT, in October and November. On the coast of Bohuslän it is again rare, though, according to MALM, young specimens in pursuit of Herring-fry and Sprats sometimes come within reach of the seine in shoals. The first Swedish specimen preserved for scientific purposes was obtained by S. LOVÉN in 1861 in central Bohuslän. This specimen is about 3 dm. long. In more recent years, according to MALM, three solitary specimens between 3 and 4 dm. long have been taken on hand-lines and Haddock-lines in 16—20 fathoms of water off Domsö, Vinga, and Paternoster Rock. During the winter of 1866 a larger number of specimens, 15—17 cm. long, were taken off Fjellbacka in a seine during the Sprat-fishery. In 1881 the Royal Museum received from Mr. C. A. HANSSON a specimen 36 cm. long that had been taken in May on a long-line shot at a depth of between 50 and 70 fathoms, between the Koster and Tister Islands. Two more specimens have since been taken in the north of Bohuslän by the same indefatigable collector, in 1890 and 1892 respectively.

It is very probable that the Poutassou is more frequently taken in Sweden, for the fishermen in general set no value upon it, and therefore do not take the trouble to preserve it. Still the flesh, according to DAY, is of good flavour, but soft, and rapidly decomposes. The spawning-season occurs probably at the beginning of the year. In July COUCH found multitudes of young specimens about 5 in. long, on the English coast and not far from land.

GENUS **MERLUCIUS.**

Two fully developed dorsal fins, the posterior, as well as the single anal fin, being, however, more or less incised at the margin behind the middle, sometimes so deeply that the fin seems to be divided in two. Caudal fin in adult specimens truncate or forked. Peduncle (finless part) of the tail distinct. Ventral fins normal, but with 7 rays. Jaws and vomer furnished with teeth. Branchiostegal rays 7.

This genus comes so near the preceding one (*Gadus*) that it is only for the sake of systematical consistency that we keep them apart, as we are in any case compelled, for the present at least, to employ the different degrees of differentiation shown by the vertical fins as the most important generic characters of the Gadoid family. The number of rays in the ventral fins seems, however, to give us a constant character, if we except FABER'S[a] description of *Merlucius argentatus*, a species which, to the best of our knowledge, has never reappeared. In the pyloric appendages this genus corresponds most nearly, as we have mentioned above, to the last species of the preceding genus, there being only one appendage at the pylorus. But in this genus the two lobes of the liver are developed to such an extent that, in some cases at least, the liver is large and broad, occupying the whole breadth of the abdominal cavity below and behind almost to a line with the vent, where in some Hakes it is continued, in the posterior prolongation of the cavity, by a lobe on the right side, the left lobe being wanting behind. Still there is considerable variation in this respect, for in one specimen of our Hake we find only a narrow lobe of the liver and this on the left side of the stomach, which extends nearly to the vent. In the form of the body, however, which is terete and elongated, the genus *Merlucius* comes nearer the small Gadoids, especially *saida*, and in this respect forms a transition from the Ling-type. This state of transition also appears in the form of the caudal fin, which in young Hakes, as in the Ling, is rounded, but in older specimens becomes truncate or even forked. In the structure of the skeleton the Hake is most nearly approximated to *navaga*, by the large, broad, and inferiorly concave, transverse processes of most of the abdominal vertebræ; but the structure of the skull is characteristic of the genus, the two frontal bones proper being distinctly separated from each other by a suture, and the occipital ridge, which in the genus *Gadus* advances without a division and with sharp edge, forward over the forehead to the middle or at least to the hind part of the orbits, being here divided, and running in an oblique, forward and outward direction over the entire upper surface of each of the frontal bones. At the middle of its length each of the frontal ridges is met by a similar ridge, running forward and inward from the upper surface of each of the squamosal bones; and thus a W-shaped figure of osseous ridges is formed, more or less distinct even externally on the forehead and occiput. In all the forms of this genus the lower jaw projects beyond the tip of the snout; the branchiostegal membranes are not coalescent, but partially cross each other at the point of their attachment to the isthmus; and the jaw-teeth as well as the teeth on the laterally extended head of the vomer are set in two rows, scattered and pointed like canine teeth but of uniform size in each row, larger and capable of being bent inwards in the inner row. The point of the chin is without any barbel.

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[a] *Fische Islands*, p. 90.

The variety of form within the genus is not great. The number of known species would be five, if two of them[a] were described with sufficient accuracy to have a claim to scientific recognition. The three species of which there is no doubt, belong to the north of the Atlantic and Pacific Oceans.

The genus received its name of *Merlus* or *Merlucius* at the hands of the contemporary writers (1554), BELON[b] and RONDELET[c], but was known even to the ancient Greeks, according to ARISTOTLE and ATHENÆUS, by the name of *ὄνος*. LINNÆUS, however, in the tenth edition of *Systema Naturæ*, having given our Hake the name of *Gadus merluccius*, RAFINESQUE[d] raised this specific name to a generic rank. The original spelling was restored by RISSO[e], and has subsequently won wider and wider recognition. It also enables us without complete tautology to retain the Linnæan specific name for

THE HAKE (SW. LYSING OR KUMMEL).

MERLUCIUS MERLUCCIUS.

Plate XXV, fig. 1.

Body elongated and terete, the greatest depth being about 13—$16^1/_2$ %[f] of the length, and the greatest thickness about 70—90 % of the former. Length of the head about 28—$24^1/_2$ % of that of the body. Bend in the margin of the dorsal and anal fins only slightly marked, and their posterior lobes rounded. Length of the pectoral fins about 12—$16^1/_2$ % of that of the body, and equal to or only slightly greater than the postorbital length of the head, which measures more than 12 % of the length of the body. Ventral fins as a rule in young specimens longer, in old slightly shorter than the pectoral fins. Number of rays in the first dorsal fin at most 11. Least breadth of the interorbital space more than 70 % of the length of the base of the first dorsal fin.

R. br. 7; *D.* 9—11 37—39[g]; *A.* 37—39[h]; *P.* 13—14[i]; *V.* 7; *C.* $x + 18—20 + x$; *Vert.* 50—52.

Syn. *Gadus* dorso dipterygio, maxilla inferiore longiore, ART., *Gen.*, p. 22; *Syn.*, p. 36. *Lysing*, STRÖM, *Sondm.*, *Beskr.*, part. I, p. 295.

Gadus Merluccius, LIN., *Syst. Nat.*, ed. X, tom. I, p. 254; *Fn. Suec.*, ed. 2, p. 113; (*Merlucius*), *Mus. Ad. Frid.*, tom. 2:di prodr., p. 60; MÜLL., *Zool. Dan. Prodr.*, p. 41; RETZ., *Fn. Suec. Lin.*, p. 321; HOLLB., Gbgs Wett., Witt. Samh. N. Handl., V (1822), p. 38 cum fig.; NILSS., *Prodr. Ichth. Scand.*, p. 44; SCHAGERSTR., Physiogr. Sällsk. Tidskr., p. 302.

Grand Merlus, DUHAM., *Tr. Pêches*, part. II, sect. I, p. 141, tab. XXIV.

Merluccius smiridus, RAFIN., *Caratt.*, p. 25; JORD., GILB. (*Merlucius*), Bull. U. S. Nat. Mus., No. 16, p. 809; COLL., N. Mag. Naturv. Christ., Bd. 29 (1884), p. 83; LILLJ., *Sv.*, *Norg. Fn.*, *Fisk.*, vol. 2, p. 120; HANSEN, *Zool. Dan.*, *Fiske*, p. 76, tab. IX, fig. 9.

Merlucius esculentus, RISSO, *Eur. Mérid.*, tom. III, p. 220.

Merluccius vulgaris, FLEM., *Brit. Anim.*, p. 195; SUND., v. WRIGHT, *Skand. Fisk.*, ed. I, p. 145, tab. 33; KR., *Danm. Fiske*, vol. 2, p. 140; NILSS., *Skand. Fn.*, *Fisk.*, p. 570; THOMPS., *Nat. Hist. Irel.*, vol. IV, p. 184; GTHR, *Cat. Brit. Mus.*, *Fish.*, vol. IV, p. 344; COLL., Forh. Vid. Selsk. Christ.

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[a] *Merlucius argentatus* from Iceland and *M. Gayi* from Chili.

[b] *La nature et diversité des poissons*, p. 116.

[c] *De piscibus*, lib. IX, p. 273.

[d] *Caratteri di alcuni nuovi Generi* etc. (1810), p. 25. RAFINESQUE here mentions two species, LINNÆUS's *Gadus merluccius* and his own *Merluccius smiridus*, both from the Mediterranean and belonging to his genus *Merluccius*. In the same year, however, he included the Hake in *Indice d'Ittiologia Sicilana*, p. 12, under the name of *Onus riali*, a generic name which was unquestionably used here in its right place, and which we should have adopted, if RISSO had not given it a different application which has gained fairly general recognition in recent times.

[e] *Europe Méridionale* (1826), tom. III, p. 220.

[f] In gravid females as much as 20 %.

[g] 36—40, according to MOREAU.

[h] Sometimes 36, according to MOREAU.

[i] ,, 12, ,, ,, ,,

1874, Tillægsh., p. 114; Winth., Naturh. Tidskr. Kbhvn, ser. 3, vol. XII, p. 31; Gigl., Espos. Intern. Pesc. Berlino 1880, Sez. Ital. Cat., p. 96; Mor. (*Merlucius*), *Hist. Nat. Poiss. Fr.*, tom. III, p. 251; Day (*Merluccius*), *Fish. Gt. Brit., Irel.*, vol. I, p. 300, tab. LXXXV, fig. 1; Apostol. (*Merlucius*), *Pêche en Grèce*, p. 29; Möb., Hcke (*Merluccius*), *Fisch. Osts.*, p. 80; Olsen, *Piscat. Atl.*, tab. 19; Storm, N. Vid. Selsk. Skr. Trondhj. 1883, p. 34; Bncke, *Handb. Fischz. Fischer.* (M. v. d. Borne), p. 105.

Merlucius sinuatus, Swains., *Fish., Amphib., Rept.*, vol. I, p. 319, fig. 73, vol. II, p. 390.

Merluccius Linnei, Malm, *Gbgs. Boh. Fn.*, p. 489.

The Hake often attains a length of 12 dm., but in Scandinavian waters it is generally of a smaller size. The following description is based on eight specimens preserved in spirits, from the Sound, Bohuslän, and the Mediterranean, the largest specimen 64 cm. long, the smallest 16 cm., and on a note left by Fries, which contains the dimensions of a new-caught specimen 6 dm. long.

Our Hake is most easily distinguished from its recognised congeners[a] by its shorter pectoral fins and broader forehead, by the smaller number of rays in the first dorsal fin, and by the generally shorter base of this fin.

The middle rays of the caudal fin measure $^1/_{11}$[b], and the length of the head to the tip of the operculum slightly more than $^1/_4$[c], of the total length of the body, including the caudal fin. The greatest depth of the body is $^1/_6$ of the total length[d], and the greatest breadth or thickness at least about $^2/_3$ of the former.

The scales are firmly attached and large in comparison with those of the other Codfishes, though the largest scales of a Hake 245 mm. long are not more than about 2 mm. in length, and in a specimen 42 cm. long not more than about 3 mm. broad. On an average we find 145 scales in a row along the sides of the body below the lateral line, the variations apparently running between 138 and 154. They are regularly arranged, rounded, and distinctly imbricated. One peculiarity of their structure has already been remarked in part by Kroyer. In the genus *Gadus* in general both the concentric and the radiating striæ are fairly distinct and almost equally defined, the thin and transparent scale presenting under the microscope a chequered appearance, with oblong, square patches raised above the surface. In the Hake, on the other hand, at least in young specimens between 2 and 3 dm. long, only the concentric, raised striæ are quite distinct when only moderately magnified. Beneath a powerful microscope, however, a network of finer striæ between the concentric ones appears on the hind (free) and more rounded part of each scale; and on the anterior (concealed) part of the scale, which is rather more pointed, the spaces between the concentric striæ are irregularly broken up into elongated markings (lacunæ[e]), as it were notched at the margin.

The head is conical and anteriorly depressed, the circumference, seen from above, being parabolic[f]. The upper surface is fairly broad, convex or more nearly flat, the profile being straight without any depressions or ridges in fresh specimens. The W-shaped figure is thus rather indistinct. A uniform covering of small scales extends forward to the upper lip, which is however naked. The least breadth of the interorbital space varies between 7 and 8 % of the length of the body, 25 and 30 % of the total length of the head, about 50 (sometimes 49) and 60 % of the postorbital length of the head, or 72 and 85 % of the base of the first dorsal fin. The opercula and the sides of the head are scaly. The eye is round, closely surrounded by the well-defined margin of the rather oblong orbit. The hind margin of the latter generally lies nearly at the middle of the length of the head, though the postorbital length of the head varies between $46^1/_2$ and 53 % of its total length. The length of the eye itself varies between about $18^1/_2$ % of the length of the head (in specimens 16 cm. long) and about 14 % thereof (in specimens 64 cm. long), being in young specimens generally rather more, in old distinctly less, than half the length of the snout.

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[a] The North American *Merlucius bilinearis*, from the Atlantic, and *Merl. productus* from the Pacific.

[b] Varying, according to our measurements, between 9 (sometimes 8) and 10 %.

[c] Varying, according to our measurements, between about 28 and 25 % (sometimes $24^1/_2$ %).

[d] Varying, according to our measurements, between about 13 and $16^2/_3$ %. In v. Wright's figure, however, which is certainly true to nature, the depth of the body is still greater.

[e] Cf. Baudelot, *Écailles des poissons osseux*, Arch Zool. Expér., tome 2 (1873), pl. VII, fig. 4.

[f] The head is very like that of the Pike, and this resemblance is still further enhanced by the appearance of the teeth. Hence the name of *Merlucius*, a shorter form of *maris lucius* (Sea-Pike). The derivation suggested by Faber, from *maris lux* has nothing to recommend it, for this fish is by no means one of the brightest in the regions where the name has originated, though in northern latitudes the rather lustrous surface of its body has given rise to the name of *Lysing* (*Shiner*).

The nostrils lie near the eye, being separated from it by a distance which is $^1/_3$ of that between the eye and the tip of the upper jaw. The anterior nostril is round, the posterior crescent-shaped. The maxillary bones extend back to a line with the middle of the eyes, the distance between the tip of the snout and their hind extremity being often exactly half the length of the head[a]. The lower jaw projects considerably beyond the upper, its length being about 61 %[b] of that of the head. Some of the teeth are large (3 mm. long in a specimen 42 cm. in length), firmly set, pointed, slightly recurved, and sparsely set in a single row, containing about 15 teeth on each side of the upper jaw. Besides these we find small teeth in both jaws, in the upper jaw between and within the large ones, and in the lower jaw a row of fairly large teeth outside the former row. The vomerine teeth form a transverse semicircle in the roof of the palate, being set in an irregular, double row. The pharynx is also furnished, as usual, with three dentated, upper pharyngeals. The tongue is fleshy, large, and flat. The gill-opening is fairly large, the upper margin of the operculum being free up to the lateral line near the occipital bones. The branchiostegal membrane is large, with exposed margin and 7 large, only slightly flattened rays. Underneath it is divided forward to the middle of the lower jaw. There is no trace of a barbel. The branchial arches are, as usual, 4 in number, and the hindmost gill-slit is rather narrow. The gill-rakers in the outer row on the first branchial arch are pectinal, but scattered, only 7—9 on each side; in the other rows they are tubercular.

The body is elongated, only slightly compressed, and broadly rounded at the dorsal and ventral margins, each of these margins being furnished with a deep groove in which the dorsal and anal fins are set, and into which they may be almost entirely depressed. As we noticed in the last forms of the preceding genus, here too we find, in the hind parts of the dorsal and ventral profiles, at the spots which correspond to the beginnings of the third dorsal and second anal fins in the preceding genus, a break from which these profiles converge more sharply towards the base of the caudal fin. The least depth of the tail is about 4—4$^1/_2$ % of the length of the body or about 13$^1/_2$—17 % of the length of the head.

The lateral line begins at the sides of the occiput and runs almost straight, in a direction sloping slightly downward from the back, to the middle of the caudal fin. It is deeply depressed, sharply defined, and perfectly naked. Along its whole length we find rather fine tubercles or projections, with the ordinary apertures for the passage of water to the sensory organs and for the discharge of mucus, set at intervals about equal in length to three of the neighbouring scales. The first 10 or 11 apertures are double, the rest simple, and the posterior ones rather indistinct.

The vent is situated just in front of the beginning of the anal fin, which lies far in front of the middle of the body, at about the beginning of the third fifth of its length[c], a little behind or in front of the perpendicular from the tip of the pectoral fin.

The pectoral fin of each side is inserted below the tip of the operculum. Its length is between about 14 (sometimes only 12) and 16$^1/_2$ % of that of the body. It contains 13 or 14 rays, the first of which is rather small, the second $^4/_5$ of the fin in length, and both simple. The other rays are doubly bifid, the sixth ray is the longest, and the length of the last ray is $^2/_3$ of that of the fin.

The ventral fins are firm and elastic, in young specimens longer than or equal in length to the pectoral fins, in old ones shorter than the latter. They contain 7 rays, the first simple and measuring $^2/_3$ of the fifth, which is the longest. The length of the last ray is $^6/_7$ of that of the fifth. Thus, as appears from the relative length of the rays, these fins are obtusely rounded, with even margin and without any perceptible elongation of any of the rays.

The first dorsal fin begins close behind the perpendicular from the base of the pectoral fins, at a distance from the tip of the snout of between about 27 (sometimes 26) and 29 % of the length of the body. It is almost triangular, and is generally composed of 10 or 11 rays, the first simple and in length $^3/_4$ of the second, which is the longest ray in the fin, measuring about 12—10$^1/_2$ % of the length of the body, and, like the other rays, bifid. The last rays are small. The base of the fin measures 9—9$^1/_2$ % (sometimes 10 %) of the length of the body.

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[a] Varying however, according to our measurements, between about 47 and 51 %.

[b] Varying, however, between about 58 and 61$^1/_2$ %.

[c] At a distance from the tip of the snout that varies between about 40 and 42$^1/_2$ % of the length of the body.

The second dorsal fin is separated from the first by an interval equal to the space occupied by two rays, and begins at a distance from the tip of the snout equal to about $39^{1}/_{2}$—38 % of the length of the body, or slightly less than the base of the fin, which measures about 41—$44^{1}/_{2}$ % of the length of the body. It is made up of 37—39 rays, most of which are doubly bifid. The first 22 or 21 form a fin of nearly uniform height, slightly lower behind, the tip of each ray projecting in the shape of a small, flat lobe beyond the fin-membrane. The following 17 or 18 rays do not extend beyond the membrane, which forms an evenly rounded and distinctly higher part of the fin. The first of these rays is almost simple, being only indistinctly branched at the tip, and the second and third only slightly surpass it in this respect. These three rays gradually increase in height, the next six are of almost equal length, and the following ones grow rapidly shorter. At the end of the first part of the fin the membrane becomes thin and fragile; in the posterior part it is much stronger. Everything shows that the fin may be regarded as consisting strictly of two fins, which are of different structure and begin, as in most of the Cods, with shorter, more nearly simple rays, but have not separated from each other.

The anal fin is of exactly the same structure — sometimes of exactly the same extent — as the second dorsal, generally containing 22 rays in the first part and 15 or 16 in the second. The first ray is rather short, the second and third rays gradually longer.

In adult specimens the two middle rays of the caudal fin are so much shorter than the outer ones that, when the fin is expanded, the hind margin becomes quite straight. Between the two corners we find 18—20 thick, doubly bifid rays, and outside these rays, on either side, 6—8 others, which grow gradually shorter in front and are closely united, the outermost ones being indistinct. The number of the rays may thus rise to 36, perhaps more. In one specimen, however, Sundevall found only 29 (6+17+6).

The colour is silver-gray, on the back blackish gray. During life the fish has a bright lustre, which is perhaps the origin of the Norwegian name of *Lysing*. The Greeks and Romans were of quite another opinion, for they gave the Hake the name of *ass* (Gr. *ὄνος*, Lat. *Asellus*) from its gray colour, which is far eclipsed in brightness by the Mediterranean fishes in general. This name is still preserved in *Nasello*, the Sardinian title of this fish. In the rest of modern Italy it is known as *Merluzzo*. The iris is also silver-gray, but in the living fish has a dash of golden colour above. A small blackish spot appears at the base of the pectoral fin. The mouth and the walls of the branchial arches are blackish.

The rather short and wide œsophagus passes into a large, saccate, thick-walled stomach. When this is empty, it shrinks together, with the inner surface in creases and with one or two external transverse folds at the blind end. The intestine, which issues from the side of the anterior end of the stomach, is narrow and short and forms only two bends. Just at the beginning it is furnished with one single appendage, which is rather short and resembles a small round pouch of the same width as the intestine, furnished within with transverse folds. As we have mentioned above, the liver may be large, though its development, here as in most of the Codfishes, is subject to considerable variation. In specimens preserved in spirits it is reddish yellow, in fresh ones, according to Duhamel and Hollberg, whitish gray. The gall-bladder is green. The two ovaries have a common opening into the cloaca, behind the orifice of the intestine. Hollberg estimates the number of the eggs in a large female at two million, Olsen at seven million. The air-bladder is large, rather firm, and hard. It is united by ligaments to the transverse processes of the abdominal vertebræ, to the ribs above the intestinal canal etc., and thus separates these parts from the kidneys, which lie uppermost, under the spinal column. The peritoneum is black throughout.

The Hake is a true marine fish, which seldom enters the island-belts. Still, in the island-belt of Bohuslän for example, young specimens are found, though in small numbers, all the year round. The Hake always hugs the bottom, except when it chases its prey. During the greater part of the year it lives alone, or follows the Herring and Mackerel shoals in companies; but in the spawning-season it collects in fairly large shoals at the spawning-places.

In the Cattegat the spawning-season occurs at the middle of July; but farther south the Hake spawns earlier in the year, at the end of winter or in spring, though even there the season may be later, as was the case, according to Couch[a], on the English coast in

[a] *Fishes of the British Islands*, vol. III, p. 100.

1837, in which year the Hake had not finished spawning before August. According to the unvarying assertion of the fishermen of Bohuslän there is only one single bank in the whole of the Cattegat where the Hake assembles in numbers to spawn. This spot is known as *Kummelbanken* or *Kummelgrund* (Hake Bank or Hake Shoal), and lies W.S.W. of Gothenburg, in the middle of the Cattegat, near the Sör Is. It is rather small, consists of sand and shingle, and lies in 16—22 fathoms of water. On this bank Hakes collect in large shoals to spawn, from the middle of July to the middle of August. After this period they disperse again. According to some of the fishermen they reappear at the same spot in spring, when they sometimes come near the land. From this we might perhaps conclude that it sometimes spawns as early here as in the south.

According to Schagerström the Hake is rare in the Sound, but is known to the fishermen by the name of *Lubb*. The Royal Museum has received from Trybom a female, about 5 dm. long and with only slightly developed ovaries, which was taken off Råå, near Helsingborg, in the latter half of October, 1882. Möbius and Heincke give two instances, in November, 1872 and December, 1873, of the occurrence of the Hake in Kiel Bay. In the Great Belt, according to Hansen, it has been taken off Corsoer. It seems never to have penetrated farther into the Baltic. The popular name of the Hake in Bohuslän and at Kullen, *kummel*, seems to be a corruption of the Norwegian *kulmund* (Coal-mouth), from the black colour of the mouth. *Lysing* is the ordinary name of the species in Norway, where, according to Collett, it is not rare, but occurs only sparingly up to Trondhjem Fjord. North of this locality only solitary specimens have been met with, as for instance in March, 1883, when a specimen $13\,^1/_2$ dm. long was caught off Lödingen in the Lofoden Islands.

The Hake occurs throughout the North Sea. It is extremely plentiful at a few spots on the coast of Brittany and the south-west coast of England and all round Ireland, but is said to be rare to the north-west of Scotland. Off the Faroe Islands it is not known, and the *Lysi* of Iceland is undoubtedly a different species, unless, as seems more probable, Faber's description of it is due to a confusion between two species. On the coast of the Spanish Peninsula the Hake is found at several spots, and in the Mediterranean, where it is caught in large quantities, it takes the place of the Cod, which does not occur there.

Except during the days occupied by the spawning the Hake is extremely voracious and, therefore, easily taken on the hook. It lives chiefly on fish, Herrings, Mackerel etc., and is said to destroy more than it can devour. It eagerly follows the Herring and Pilchard shoals. It drags the Pilchards out of the net, though it often entangles itself in the meshes, and thus pays the penalty of its voracity. During the seine-fishery for Herrings Hakes have been found in the seine that have glutted themselves quite helpless on the catch. It is also stated that the Hake, when drawn out of the water, evacuates the contents of its stomach. A specimen opened by Sundevall, however, contained three young Herrings, and a Hake about $6\,^1/_2$ dm. long which was forwarded to the Royal Museum from Strömstad by Baron Cederström, had two well-preserved Sprats in its stomach. It is probably the voracity of the Hake that has given rise to the incredible tale told by Ström, on the authority of the Norwegian fishermen, that three fish were once caught on the same hook, the hook having pierced through the belly of the first, and having been at once swallowed by the second and in its turn by the third.

This fish is apparently periodic. In the Cattegat, according to Hollberg, it was extremely plentiful during the Herring-fishery for some years about 1780, more Hakes being taken than could be made use of. Then it became rare, but was again caught in fairly large quantities from 1801 to 1803, when several hundred barrels were salted. After this period, when the Herring disappeared, it again became so rare that it was not until 1821, after several years' enquiry, that Hollberg succeeded in obtaining a specimen from the Cattegat for purposes of description. About 1830 it was again abundant in Bohuslän, but about 1840 the numbers again decreased. At the present time, now that the Herring is plentiful, the Hake is not rare, at least on the north coast of Bohuslän, according to Cederström. This fluctuation of the supply has much that reminds us of the periodicity of the Herring, and may probably be explained in the same way. Apart from the fact that the roving expeditions of a fish-of-prey are determined by the abundance of its food, they are also undertaken for purposes of reproduction. In the Cattegat the Hake has but few spawning-places, perhaps, as hinted above, only one; and, like many other species, probably keeps persistently to its accustomed haunt. But when it is disturbed while spawning, and owing to its voracity is caught freely before and after the spawning-season — even during this period, for all Hakes do not spawn at the same time — it soon results that an adequate number of adult individuals is not forthcoming. In this case the fish must become rare, until the fishermen have had time to desert the station as unproductive, and a new stock of adult fish has assembled or grown to maturity, and been permitted to breed in peace for a generation or two.

When fresh the Hake is regarded as an inferior fish, especially when it is caught on a muddy bottom. On a stony and hard bottom it is said to be of better quality. Salted and dried, like the other Codfishes, in the form of stockfish, rotkiærs etc., the Hake is said to be nearly as good as Cod prepared in the same manner. In this form considerable quantities are exported to Roman Catholic countries, and consumed during Lent, when meat is forbidden.

In the Cattegat the Hake is caught partly with long-lines and partly with hand-lines used for other fish. On the fishing-bank described above the fishery is carried on during the spawning-season, at the end of July and beginning of August, with hand-lines and Haddock-lines. The bait consists of Herring or, still better, of Mackerel, and sometimes of a bit of the fish taken from the belly of the Hakes already caught. Hundreds of boats, usually with a crew of three men, assemble there, and if the fishery is successful, a single forenoon will suffice to give them a full load. On the coast of Brittany the Hake is the object of a fairly important fishery, pursued in the open sea, partly with nets and partly with lines, in large boats, each with a crew of nine men. This fishery is carried on only at night, and affords employment to a large number of persons.

(Sundevall, Smitt.)

Genus **MOLUA**.

Two fully developed dorsal fins and one anal fin. Vertical fins well separated, in adult specimens with a distinct, finless peduncle of the tail. Ventral fins with six rays. Caudal fin more or less rounded. Intermaxillary teeth of fairly uniform size, but the teeth in the lower jaw and on the head of the vomer interspersed with large canines. Branchiostegal rays 7.

This genus, which was combined by Cuvier with the following one, was first separated from it by Nilsson[a], though, like Fleming[b], he had previously[c] employed the same generic name for the group which Cuvier and Risso called *Lotta*. The name of *Molua*, as well as *Morrhua* (*Morhua*), is a Latinized form of the French *morue*, and was applied by Rondelet[d] to the Cod, but altered by Aldrovande to *Molva* and employed by Charleton[e] for both the Ling and the Cod. As in the case of the preceding genus, we restore the original name, by which course we are enabled without absolute tautology to retain the Linnæan specific name of the type of the genus.

The genus possesses its principal systematic importance in the capacity of an intermediate stage between the preceding genus and the following one. This appears most distinctly in the structure of the second dorsal and the anal fins, which in one species, our common Ling, are almost entirely without that trace of division which we have observed in the preceding genus, but in the second species, *Molua dipterygia*, do not indeed show these traces as distinctly as *Merlucius*, but still plainly enough. In *Molua dipterygia* the caudal fin is much more abruptly rounded — thus coming nearer *Merlucius* — than in our common Ling, which in this respect also more nearly resembles the Burbot. The number of rays in the ventral fins (less than 7), a number which may, however, occur in *Lotta*, and the canine teeth in the lower jaw and on the vomer are, therefore, the most trustworthy characters of the genus *Molua*. *Molua* is further distinguished from *Lotta* by the smaller breadth of the interorbital space[f], the shorter ventral fins[g], the narrower (less terete) form of the body[h], and the more forward position of the first dorsal fin[a]. In the Southern Hemisphere *Molua* is replaced by the genus *Lotella*, which should perhaps be united with it.

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[a] *Skand. Fn., Fisk.*, p. 573 (1855).

[b] *Brit. Anim.*, p. 192.

[c] *Prodr. Ichth. Scand.*, p. 45 (1832).

[d] *De Pisc.*, lib. IX, cap. XIV.

[e] *Onomast. Zoic.*, p. 121. *Molva major* (the Ling) and *Molva minor* (the Cod).

[f] As a rule less than $^1/_5$ of the length of the head.

[g] Less than 12 % of the length of the body.

[h] Greatest breadth of the body as a rule less than 45 % of the length of the head.

The body is covered in this genus with small, thin, oblong, elliptical scales, with a more or less (sometimes considerably) eccentric nucleus, and with the striations arranged according to the same type as in the Cods but denser. The concentric striæ are so predominant that the radiating ones form only narrow connecting lines, very often incomplete, between the concentric striæ; but the radiating lines are far from always opposed to or in continuation of each other on each side of a concentric striation. In this manner, however, a network is formed, as in the Cods, with quadrangular meshes; and in every mesh the scale-substance is thickened or raised, at least on the hind (free) part of the scale[b]. Where the radiating lines are interrupted, these thickened parts assume a continuous, moniliform appearance, with one row of beads for each of the concentric striæ.

Only two or perhaps three species of the genus *Molua* are known. They belong to the Mediterranean and the North Atlantic. The two species which occur within the limits of the Scandinavian fauna may be distinguished as follows:

A: Least depth of the tail less than $^1/_6$ of the length of the head . . *Molua dipterygia.*
B: Least depth of the tail more than $^1/_5$ of the length of the head........................ *Molua molva.*

THE LESSER LING (SW. BIRKELÅNGAN).

MOLUA DIPTERYGIA.

Plate XXVI, fig. 3.

Body elongated, almost Eel-shaped, its greatest depth being about $^1/_{10}$—$^1/_{12}$ of its length. Least depth of the body (about $2^1/_2$ % of its length) less than 15 % of the length of the head or than half the length of the middle caudal rays. Total length of the head (in adult specimens) less than $^1/_5$, its postorbital length less than $^1/_{11}$, of the length of the body. Base of the first dorsal fin less than $^1/_{10}$ of the length of the body or than $^1/_5$ of the base of the second dorsal fin, and less than or at most $^1/_5$ greater than its own height. The second dorsal fin begins at a distance from the tip of the snout less than 35 % of the length of the body, and its base occupies at least half of the length of the body. Base of the anal fin also greater than the distance between this fin and the tip of the snout, and measuring at least 45 % of the length of the body. Coloration above reddish or brown, below white or grayish; outer part of the pectoral fins, hind lobes of the second dorsal and the anal fins, and outer parts of the caudal fin, above and below, blackish. Iris orange.

R. br. 7; *D.* 11—14 74—83; *A.* 70—81; *P.* 18—20; *V.* 6; *C.* $x+24—30+x$; *Vert.* 78.

Syn. *Byrkelange*, STROM, *Sondm. Beskriv.*, pt. I, p. 275; ID., Trondhj. Selsk. Skr., pt. III, p. 446, tab. 8; *Gadus* dipterygius, cirratus, max. infer. longiore, p. anal. LXX, MULL., *Zool. Dan. Prodr.*, p. 42.
Gadus dypterigius, PENN., *Introd. Arct. Zool.*, ed. II, vol. I, p. CXXIV.
Gadus Byrkelange, WALB., *Ichth. Art.*, pt. III (*Gen. Pisc.*), p. 135; COLL. (*Molva*), Forh. Vid. Selsk. Christ. 1874, Tillægsh., p. 116; MALM, *Gbgs, Boh. Fn.*, p. 492; MELA, *Vert. Fenn.*, p. 302, tab. IX; STORM (*Lota*), Norsk. Vid. Selsk. Skr. (Trondhj.) 1883, p. 35; COLL. (*Molva*), N. Mag. Naturv. Christ., Bd. 29 (1884), p. 84; LILLJ., *Sv., Norg. Fisk.*, pt. 2, p. 139; HANSEN, *Zool. Dan., Fiske*, p. 83, tab. X, fig. 3, *a*.
Gadus abyssorum, NILSS., *Prodr. Ichth. Scand.*, p. 4; KR., (*Lota*), *Danm. Fiske*, vol. 2, p. 167; NILSS. (*Molva*), *Skand. Fn., Fisk.*, p. 577.

Obs. The question whether the Mediterranean *Molua macrophthalma* (*Phycis macrophthalmus*, RAFIN., *Caratteri* etc., p. 26, tab. IX, fig. 3; *Lotta elongata*, RISSO, *Eur. Mér.*, tom. III, p. 217, fig. 47) is a distinct species from *Molua dipterygia*, seems to require further elucidation. Both NILSSON (*Skand. Fn.*) and LILLJEBORG have pointed out the great similarity between them, the latter writer with the reservation that a difference exists in the texture of the scales. This difference seems to consist in the fact that in the Mediterranean form the radiating striæ are entirely wanting, and that the moniliform appearance of the concentric rings has thus disappeared. To judge by the measurements given by LILLJEBORG, the Mediterranean form has also a still shallower peduncle of the tail (least depth of the tail only $11^1/_3$ % of the length of the head) and a shorter first dorsal fin (its base only 11 % of that of the second dorsal fin), this form being thus still further removed from the common Ling than *Molua dipterygia*. To judge by COSTA'S figure (*Fauna del regno di Napoli, Pesci*, parte prima, Malacotterigii Sottobranchiali, p. 15, tav. XXXVIII) *Molua macrophthalma* seems also to be of a peculiar coloration, with transverse spots, perhaps traces of the earlier stages of its development, on the sides of the body. Still these differences cannot be of any especial significance; and in the coloration in particular, in the distribution of the black colour on the vertical fins, we find an eminently characteristic resemblance between the two forms. Thus, whether we choose to regard these forms as distinct species or merely as local varieties, we have here, as for example in the case of *Scorpæna dactyloptera* (see above, p. 155), an evident connexion between the deep-sea faunæ of the Mediterranean and of Scandinavia.

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[a] Distance between the first dorsal fin and the tip of the snout less than 30 % of the length of the body.

[b] Cf. the scales of the Eels — see BAUDELOT, *Arch. Zool. Expér.*, tom. 2 (1873), p. 198, pl. VIII, fig. 1—4.

The Lesser Ling seldom attains a length of more than 1 metre, though, according to NILSSON, specimens at least 5 feet (15 dm.) long are sometimes met with. Its external form and external characters have already been compared by STRÖM to those of the Hake, with which genus it is closely connected in several respects. The body is, however, still more elongated, the greatest depth being at most about $^1/_9$ (sometimes only slightly more than $^1/_{12}$) of the length, and the least depth less than 3 % (2·7—2·5 %) of the latter. In front the body is terete, the breadth being about $^4/_5$—$^9/_{10}$ of the depth; behind the lateral compression becomes more and more pronounced, the breadth (thickness) of the body at the point where the depth is least, being not even $^1/_2$ of the depth. The curves of the dorsal and ventral profiles are equal and much more elongated behind than in front. At the point which corresponds to the incision in the margins of the dorsal and anal fins in the Hake (here almost imperceptible), at the base of about the fiftieth ray of the second dorsal fin, we find a slight trace of a break, the dorsal profile sinking and the ventral rising rather more sharply back towards the base of the caudal fin.

The form of the head is a uniform transition from that of the terete forepart of the body. The snout is horizontally elliptical, vertically slightly depressed, with large, only slightly ascending mouth. The top of the head is smooth or furnished with only slightly distinct carinæ (longitudinal osseous ridges), and a little concave between the eyes. The length of the head is distinctly less than $^1/_5$ (about 19 %) of that of the body, or than $^1/_2$ (at most about 42 %) of that of the base of the anal fin. The eyes are large. Their longitudinal diameter measures in adult specimens 24—22$^1/_2$ % of the length of the head or about twice the breadth of the interorbital space, and is more than $^2/_3$ of the length of the snout, which occupies about $^3/_{10}$—$^1/_3$ of that of the head. Their upper margin lies on the same plane as the forehead; but as the fish is generally caught in very deep water, they project considerably in most cases. The nostrils are situated in the hindmost third of the length of the snout and fairly high, somewhat above the middle of the eyes. The anterior nostril is round, with the margin raised into a lobate projection behind, the posterior larger, obliquely-set, oblong or crescent-shaped, with the posterior (upper) part extended. The gape is comparatively large, and the jaws are thus fairly long, the distance between the hind extremity of the maxillary bones and the tip of the snout being about 46 or 47 % of the length of the head, and the length of the lower jaw, which in adult specimens measures 58—52 % of the total length of the head, greater than the postorbital length of the same. In all our specimens the tip of the snout projects distinctly in front of that of the lower jaw[a], which is furnished underneath with a comparatively small barbel, measuring less than half the longitudinal diameter of the eyes. The intermaxillary bones are terete, tapering gradually to a point behind, and externally passing imperceptibly into the ligamentous membrane that forms the labial margin between these bones and the hind extremity of the maxillaries, which is flat and somewhat extended, but arched downwards, and from which a similar membrane runs forward to the anterior part of the lower jaw, forming an underlip, more fleshy in front than behind. The intermaxillary bones are furnished throughout their length with a card of rather small teeth of uniform size. The card is of fairly uniform breadth, but as usual somewhat broader in front and growing narrower behind. The lower jaw, on the other hand, contains two kinds of teeth, an outer row of small teeth, which is sometimes double, corresponding to the intermaxillary teeth, and an inner row of scattered, but large, straight, and pointed canines, about 15 in number on each branch of the lower jaw, and just at their tips more or less distinctly barbed. The head of the vomer is also furnished with similar canine teeth, set in a horse-shoe or semi-elliptical row, about 6 in number on each side. Only a trace of the transverse palatine folds is present. The tongue is toothless, fleshy, and free, flat and triangular at the tip. The gill-rakers are short and denticulated. The pharyngeal teeth are like the intermaxillary teeth. On each of the lower pharyngeals they form an oblong card, while the upper pharyngeals are united on each side into a round, convex projection, covered throughout the surface with cardiform teeth of uniform size. At the side of these projections, on the uppermost part (the epibranchial bone) of the third branchial arch a small, separate patch of teeth may be felt[a]. The gill-openings are large and admit of considerable expansion, but the branchiostegal membranes are united underneath into a broad dermal fold, free from the isthmus and extending almost to the tops of the first branchiostegal rays. The preoperculum is crescent-shaped, the interoperculum rather broad behind, the operculum rather small and deeply concave at the hind margin, and the suboperculum comparatively large. The cephalic system of the lateral line is well-developed, with distinct and sometimes open pores along the long preorbital bone as well as at the margin of the preoperculum and on the branches of the lower jaw. Straight in front of each of the nasal cavities, about half-way between it and the tip of the snout, lies a large muciferous groove, with a nostril-like and sometimes open pore.

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[a] The case may also be the contrary, according to NILSSON and LILLJEBORG.

The first dorsal fin resembles that of the Hake, and here too its height (the length of the longest ray) is generally greater than the length of the base, but subject to considerable variation, thus rendering it almost impossible to formulate any rule for this relation. The fin begins at a distance from the tip of the snout equal to about $^1/_4$ (26—25 %) of the length of the body, the length of its base varies between about $^1/_{18}$ and $^1/_{11}$[b] of the length of the body, and the length of its longest ray between $^1/_{14}$ and $^1/_{12}$[c] thereof. The shape of the fin also varies, being either triangular or rounded. All the rays, except the first and the last, may be bifid at the tip, though only indistinctly. The second dorsal fin begins just behind the end of the first or at only a slight distance from it, and is separated from the tip of the snout by a distance equal to about $^2/_3$ (61—67 %) of the length of the fin itself. It is always lower than the first dorsal fin, and in the middle third of the fin the rays are generally distinctly shorter, but at the 40th—50th ray the height again begins to increase, about the 60th ray being the longest and measuring about 6 or 7 % of the length of the body. The first three rays as well as the last are generally undivided, the others more or less indistinctly divided. The division is most distinct in the rays in the hindmost part of the fin.

The anal fin reproduces the form and structure of the second dorsal, but is lower and shorter. It begins a little behind the vent, the distance between its beginning and the tip of the snout being about 40—42 % of the length of the body, and ends a little way from the first lower supporting ray of the caudal fin, usually a little behind the perpendicular from the end of the second dorsal fin, but sometimes in a line with this latter fin, or even a little further forward.

The caudal fin is also invariably separated by a distinct interval both from the second dorsal and the anal fin. The middle of its base (the tip of the tail) lies at a distance from the ends of these fins measuring about 8 or 9 % of the length of the body. Its shape is cuneiform, with the hind margin somewhat convex or nearly straight.

The pectoral fins resemble those of the Hake, being of an oval, obliquely pointed shape. Their length — $^1/_9$ or $^1/_{10}$ of that of the body — is greater than the postorbital length of the head, and more than half as much again as the length of the snout.

The narrow ventral fins, on the other hand, differ widely from those of the Hake. As a rule they are longer than the pectoral fins, this being due to the great elongation of the tips of the rays, especially of the second one. Still, in this species too, the ventral fins become comparatively shorter during growth.

The scales are thin and small, but close-set and imbricated, extending over the whole body forward along the snout and over the greater part of the thick membrane of the vertical fins. They are largest, as usual, on the sides of the hind part of the body; but among the larger scales we find small accessory scales, the nucleus of which is sometimes extremely eccentric. The scales on the anterior part of the head and on the fins are equally small, but we have never found their nuclei to be so eccentric. In all the scales the nucleus is round and rather small. It always lies in the anterior, inserted part of the scale. The scales are either oblong or linguiform, with the anterior part broader in the ordinary scales, narrower in the accessory ones. The bead-shaped markings of their striation have already been noticed.

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[a] KROYER has remarked as a characteristic of the common Ling that in the pharynx we find on each side four, dentated upper pharyngeals, three of them united, as usual, into an oval patch furnished with teeth, and a "fourth, small, isolated bone." The true state of the case is, however, that here, as in many of the Teleosts, especially in this species and the Burbot as well as in the Hake and the larger species of the genus *Gadus* — with the exception of the Haddock — the epibranchial bones of the third branchial arch are furnished with teeth.

[b] 6·8—9·3 %, according to our measurements of 4 specimens between 56 and 85 cm. long.

[c] 7·2—8·1 %, according to our measurements.

The lateral line, which, as in most of the Cod-fishes, is scaleless, at the hind part of the tail runs fairly straight along the middle of the sides, gradually rises in front, and in the abdominal region forms a slight, but distinct arch above the pectoral fin.

The abdominal cavity with its blue-black peritoneum, is remarkably long. In a male 65 cm. in length it extends, gradually diminishing in width, behind the vent to a line with the 30th ray of the anal fin. This prolongation, however, does not contain any portion of the intestine, but is occupied by the greater part of the testes, which are divided, as in the Cods, into wavy lobes. The stomach is long, hardly marked off at all from the œsophagus, and pointed behind. The pylorus is situated at the middle of the lower (ventral) side of the stomach[a]. The pyloric appendages are long and numerous, being at least about 20 in number. The intestine first bends slightly forward from the pylorus, and then straight back to the anal region, then forward again to the pyloric region, and finally straight to the vent.

The coloration seems to be subject to considerable variation. The specimens preserved in spirits in the Royal Museum are dark or light brown on the back, the sides gradually passing into the grayish white or light bluish gray colour of the belly, which is finely punctated throughout with reddish brown. Our figure gives the coloration of a fresh specimen which was sent, packed in ice, to the Royal Museum from Gothenburg in January, 1875, by Professor MALM. The most characteristic touch is the black colour of the outer (posterior) part of the pectoral fins and the hind parts of the second dorsal, the anal, and the caudal fins. All these fins are edged with white. The bases of the pectoral fins and the caudal fin are ashy blue, but at the middle of the caudal fin we find a lighter, whitish patch between the black portions, and in the fresh specimen the sides of the base of the caudal fin were yellowish. According to MALM "the rest of the fins are blackish brown; but on the anterior dorsal fin we find an oblique, whitish stripe from the tip of the first ray to the hind part of the base."

The Lesser Ling — apart from its near relationship to the above-mentioned Mediterranean form — is strictly known only as a Norwegian species; but has long been renowned and more esteemed than the common Ling. It lives only in deep water — generally at a depth of from 100 to 300 fathoms — and is common only north of Bergen up to Finmark. There is no record of its occurrence in the Arctic Ocean east of Varanger Fjord[b]. It is also found, however, south of Bergen, and now and then enters the Skager Rack, where it has been taken in 35 fathoms of water on a bank 23 miles S.W. of Vinga. Since 1860 MALM has recorded the capture of 8 specimens off Bohuslän, and Mr. C. A. HANSSON has forwarded to the Royal Museum two specimens, both females, the first taken in October, 1888, at a depth of 80 fathoms between Norway and Koster, and the second in April, 1889, in Säcke Fjord.

Two of our predecessors, STRÖM and NILSSON, state that on the coast of Norway *Molua dipterygia* is taken,' not, as the common Ling, in the open sea, but always in the deep fjords, "where it is taken with special tackle, known as deep-sea long-lines, principally in autumn." COLLETT tells us, however, that "at several spots, especially on the off-shore fishing-banks, it is taken in so great numbers that this fishery — together with the catch of the common Ling and the larger Cods — is of importance in the manufacture of stockfish intended for exportation." It is considered better than the common Ling, at least when fresh. The Swedish name of the species (*birkelånga* = Trade Ling) denotes, according to NILSSON, that it commands a better price than the common Ling. Of its habits nothing more is known; but, to judge by its structure, they cannot differ in any essential point from those of the common Ling. In one of the males belonging to the Royal Museum the testes were so developed at the beginning of April that in this case the spawning-season might be assumed to occur in the spring or summer.

FABER (*Fische Islands*, p. 88) believed that the Lesser Ling was the young of the following species.

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[a] In the specimens before us we find the peculiarity — which often exists, however, in the common Ling too, when drawn up from a great depth — that the hind part of the stomach, up to the pylorus, is forced bodily into the anterior part.

[b] According to MELA it is rare in this fjord.

This opinion is untenable, for the two species are distinguished by constant characters; but the manner in which most of these characters develop in *Molua dipterygia*, as far as we can decide from an examination of four adult specimens and without any knowledge of the earlier stages, shows that, from a systematic and genetic point of view, *Molua dipterygia* must be regarded essentially as a predecessor of the common Ling, though the former has evidently adopted in certain respects a distinct direction of development from the common original type which we are entitled to assume. This appears from the following table of averages; which may besides serve to supplement the preceding description.

	Averages	*Molua dipterygia*[a].		*Molua molva*[b]	
		2 specimens.	2 specimens.	2 specimens.	3 specimens.
	Length of the body expressed in millimetres	606	824	319	892
1	.. .. .. base of the first dorsal fin in % of the length of the body	7.1	8.1	10.6	11.6
2	Distance between the second dorsal fin and the tip of the snout	33.2	33.5	39.3	40.0
3	.. .. .. insertion of the ventral fins and the beginning of the anal fin	24.2	25.3	27.7	29.5
4	,, ,, ,, tip of the snout ,, ,, ,, ,, ,, ,, ,, ...	41.5	41.7	46.7	48.9
5	Length of the base of the anal fin	46.5	45.1	38.1	37.9
6	.. .. .. head in % of the length of the base of the anal fin	40.3	42.0	56.6	56.8
7	Longitudinal diameter of the eyes in % of the length of the snout	76.2	67.7	61.9	47.3
8	Breadth of the interorbital space in % of the distance between the tip of the snout and the hind extremity of the maxillaries	24.6	26.0	32.3	39.1
9	Postorbital length of the head in % of the length of the base of the second dorsal fin	16.5	16.9	23.2	25.2
10	Distance between the second dorsal fin and the tip of the snout in % of the length of the base of this fin	63.5	65.3	86.1	87.6
11	Length of the pectoral fins in % of the distance between the insertion of the ventral fins and the beginning of the anal fin	42.7	41.8	33.1	31.6
12	Height of the first dorsal fin in % of the length of its base	102.9	101.4	48.7	48.9
13	Length of the snout in % of the length of the body	5.8	6.2	7.0	6.8
14	.. .. .. base of the second dorsal fin ,, ,, ,, ,, ,, ,, ,, ,,	52.6	51.3	45.5	45.9
15	Length of the snout in % of the length of the pectoral fins	56.7	59.0	76.4	73.8
16	Least depth of the peduncle of the tail in % of the length of the middle caudal rays	42.2	39.6	71.5	78.3
17	Height of the first dorsal fin in % of the length of the body	7.2	8.1	5.2	5.7
18	Least depth of the peduncle of the tail in % of the length of the body	2.7	2.5	4.8	4.6
19	.. .. head	14.2	13.4	22.3	21.7
20	Distance between the tip of the snout and the hind extremity of the maxillary bones in % of the length of the head	46.3	46.7	42.7	43.8

In the first 11 points of the comparison drawn in this table the averages run in the same direction, from a lower percentage to a higher or *vice versa*, and thus form an uninterrupted developmental series, the direction of development being the same in both species. In the next five points (12—16) the directions of development are different, *Molua dipterygia* seeming in these respects to have followed a distinct course[c] and to have had a special origin for its development. In the last four points (17—20) the direction of development is again the same, but at the origin of its course of development *Molua dipterygia* seems to be already further advanced than *Molua molva*.

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[a] Minimum length of the body in these 4 specimens 562 mm., maximum 828 mm.

[b] ,, ,, ,, ,, ,, ,, ,, ,, 5 ,, 231 ,, ,, 1,640 ,,

[c] The difference is to be explained to some extent, however, in points 13 and 14, by the fact that one of the specimens of *Molva molva* is 1,640 mm. long, and in several respects is an example of the not unusual circumstance that old age involves a reversion to the characters of youth.

THE LING (SW. LÅNGAN).

MOLUA MOLVA.

Plate XXVI, fig. 2.

Body elongated, almost Eel-shaped, the greatest depth being about $^{1}/_{11}$—$^{1}/_{8}$ of the length. Least depth of the body (about $4^{1}/_{2}$—5 % of the length) more than 19 % of the length of the head or than $^{3}/_{5}$ of the length of the middle rays of the caudal fin. Total length of the head more than $^{1}/_{5}$, its postorbital length more than $^{1}/_{10}$, of the length of the body. Base of the first dorsal fin more than $^{1}/_{10}$ of the length of the body[a] *or than $^{1}/_{5}$ of the base of the second dorsal fin, and at least about $^{1}/_{3}$ greater than the height of the first dorsal fin. Distance between the beginning of the second dorsal fin and the tip of the snout more than 38 % of the length of the body, and the length of the base of this fin less than $^{1}/_{2}$ that of the body. Base of the anal fin less than the distance between this fin and the tip of the snout, and at most about 40 or 41 % of the length of the body. Coloration above grayish brown in old specimens and brownish red in young, below white or grayish; outer part of the pectoral fins yellow; the two dorsal fins and the anal fin with a black spot on the posterior part. Iris yellow, with a reddish golden ring next the pupil.*

R. br. 7; *D.* 14[b]—16/60—68[c]; *A.* 57—65[d]; *P.* 18—19[e]; *V.* 6; *C.* $x+24$—30[f]$+x$; *Vert.* 64—65.

Syn. *Asellus longus*, SCHONEV., *Ichthyol. Slesv. Holst.*, p. 18; *Molva major*, CHARLETON, *Onom. Zoic.*, p. 121; *Gadus* No. 9, ART., *Gen.*, p. 22; *Syn.*, p. 36; LIN., *It. Wgoth.*, p. 177; *Lingue*, DUH., *Pêch.*, part. II, sect. I, p. 145, tab. XXV, fig. 1.

Gadus Molva, LIN., *Syst. Nat.*, ed. X, tom I, p. 254; *Fn. Suec.*, ed. II, p. 113; RETZ., *Fn. Suec. Lin.*, p. 322; FABER, *Fisch. Isl.*, p. 86; NILSS. (*Molva*), *Prodr. Ichth. Scand.*, p. 45; SCHAGERSTR. (*Gadus*), Physiogr. Sällsk. Tidskr., p. 302; PARN. (*Lota*), Mem. Wern. Nat. Hist. Soc., vol. VII, p. 352; KR., *Danm. Fiske*, vol. 2, p. 153; MGRN, *Finl. Fisk.* (disp. Helsingfors), p. 30; MOR., *Hist. Nat. Poiss. Fr.*, tom. III, p. 258; MÖB., HCKE, *Fisch. Osts.*, p. 82.

Molva vulgaris, FLMNG, *Brit. Anim.*, p. 192; NILSS., *Skand. Fn., Fisk.*, p. 573; GTHR, *Cat. Brit. Mus., Fish.*, vol. IV, p. 361; COLL., Forh. Vid. Selsk. Christ. 1874, Tillægsh., p. 115; N. Mag. Naturv. Christ., Bd. 29 (1884), p. 84; WINTH., Naturh. Tidskr. Kbhvn, ser. III, vol. XII, p. 32; DAY, *Fish. Gt. Brit., Irel.*, vol. I, p. 305, tab. LXXXVI; MELA, *Vert. Fenn.*, p. 302, tab. IX; STORM (*Lota*), Norsk. Vid. Selsk. Skr. Trondhj. 1883, p. 35; LILLJ. (*Molva*), *Sv., Norg. Fisk.*, vol. 2, p. 131; HANSEN, *Zool. Dan., Fiske*, p. 81, tab. X, fig. 2.

Gadus raptor, NILSS., *Prodr. Ichth. Scand.*, p. 46; SCHAGERSTR., l. c.

Molva Linnéi, MALM, *Gbgs, Boh. Fn.*, p. 491.

The common Ling, as hinted above, comes so near the preceding species that a minute description of it is hardly necessary. However, it attains a much more considerable size. Even on the coast of Bohuslän and in Christiania Fjord specimens 16 or 17 dm. long may be found. We cannot say whether it grows much larger in other localities; but PENNANT's statement[g] that he had been told of a specimen 7 feet (21 dm.) long, has been adopted in literature, and COUCH[h] had heard of a Ling from the Scilly Islands 124 lbs. (56 kgm.) in weight, and thus considerably above the ordinary size, a Ling $5^{1}/_{2}$ ft. long weighing only about 70 lbs. (32 kgm.). As a rule too, the body is somewhat deeper than that of *Molua dipterygia*, a fact which appears most distinctly in the least depth of the tail. But in all other respects the two species are so similar in form that here too we find the break in the regular backward convergence of the dorsal and ventral lines which coincides with the origin of the last dorsal and anal fins in the Cods, and which we thus have traced from the Hake, with its indication of a division in the posterior dorsal and anal fins, to the Ling, where this indication seems to be entirely wanting.

The head is distinguished from that of *Molua dipterygia* partly by its somewhat greater length —

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[a] In young specimens, however, sometimes $^{1}/_{10}$ of the length of the body.

[b] Sometimes 13.

[c] " 70.

[d] " 66.

[e] " 20 or 21.

[f] 38—39, according to LILLJEBORG.

[g] *Brit. Zool.* (1776), tom. III, p. 174.

[h] *Hist. Fish. Brit. Isl.*, vol. III, p. 92.

20—23 % of the length of the body — partly by the greater breadth of the interorbital space — more than 30 %, sometimes, in very large Ling, as much as 46 %, of the distance between the tip of the snout and the hind extremity of the maxillary bones — partly by the smaller eyes — with a longitudinal diameter of about 22—11 % of the length of the head or 65—33 % of the length of the snout in specimens between 23 and 164 cm. long — and partly by the longer barbel under the chin, measuring more than the longitudinal diameter of the eyes. The occiput and the forehead are flatter than in the preceding species. The length of the lower jaw is as a rule somewhat less than the postorbital length of the head, which is about $10^{1}/_{2}$—13 % of the length of the body. The tip of the snout generally projects beyond the lower jaw, but, as in the preceding species, the case is sometimes reversed, and a form with this characteristic is described by NILSSON under the name of *Molua raptor*. The teeth and gill-covers are like those of *Molua dipterygia*, but in old Ling the sinus in the lower posterior margin of the operculum is to a great extent filled up.

The first dorsal fin is distinguished from that of *Molua dipterygia* not only by the number of the rays, which is generally greater, but also by its more elongated form, the upper margin in young specimens being distinctly rounded and highest in the last third of its length, but in old specimens fairly straight (of uniform height). In adult specimens the rule holds good that the base of the fin is more than twice its height. The distance between the fin and the tip of the snout varies between 27 and 30 %, the length of its base between 10 and 13 %, and its height between 5 and 6 %, of the length of the body. In young Ling only the posterior rays (with the exception of the last one) are branched, but in most old specimens, on the other hand, only the first three rays and the last ray are simple. The second dorsal fin is considerably longer and contains a greater number of rays, but is of a similar structure. It begins just behind the first dorsal fin, the distance between it and the tip of the snout varying between about 38 and 43 % of the length of the body. Its length varies between 45 (sometimes 43) and $47^{1}/_{2}$ %, and its greatest height (in the posterior part) between $6^{1}/_{2}$ (sometimes 7) and 5 %, of the length of the body. Behind the middle of its length there is only a slight diminution in its height.

In this species too, the anal fin repeats the form and structure of the second dorsal, though it is shorter and lower. The distance between it and the tip of the snout, which varies between about $45^{1}/_{2}$ and 53 % of the length of the body, is always greater than its length, which varies between about 40 and 34 % of the length of the body. It ends a little in front of the perpendicular from the termination of the second dorsal fin. Its greatest height is about 6—5 % of the length of the body.

The caudal fin is much more rounded than in *Molua dipterygia*, but in specimens of equal size its length is about the same.

The pectoral and ventral fins are of essentially the same form and structure as in *Molua dipterygia*, but are usually shorter. The length of the former is always less than the postorbital length of the head; and the length of the latter, which in young specimens is much greater, diminishes so rapidly during growth that in specimens about 4 dm. long it is somewhat less than the postorbital length of the head, and in specimens 16 dm. long not even half of this length. The position of the ventral fins also varies considerably with age, in accordance with the general rule among the Teleosts, moving farther and farther forward during the normal period of growth. In Ling about 23 cm. long the distance between these fins and the tip of the snout is about $19^{1}/_{2}$ % of the length of the body, in specimens between 40 and 50 cm. long about $18^{1}/_{2}$ %, and in specimens 55 cm. long about $17^{1}/_{2}$ %. In very old specimens, however, of a length of 164 cm. for example, we may find a reversion to the juvenile characters, this percentage having again risen to 21 or 22 %.

The scales resemble those of *Molua dipterygia*, but are relatively still smaller and, together with the nucleus, more oblong and of more uniform breadth. They are rectangular and twice or three times as long as broad, with very gradually rounded corners.

M'INTOSH has investigated and described[a] the changes of growth during the embryonic stages of the Ling, as well as during its larval and postlarval stages. The systematic interest of the last of these periods of growth is especially great. At the age of 3 or 4 months, at the end of August, when the larva is between 8½ and 9 mm. long, the embryonic vertical fin is still almost continuous (fig. 124), only the hind extremity of the notochord projecting obliquely upwards in the form of a boundary between the eventual upper and lower parts of the fin. The most remarkable peculiarity lies, however, in the situation and form of the ventral fins.

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[a] *The Life-history of a Marine Food-fish*, Roy. Inst. Gt. Brit., Febr. 1, 1889. *On the development and life histories of the teleostean food and other fishes*. By W. C. M'INTOSH and E. E. PRINCE, Trans. Roy. Soc. Edinburgh, vol. XXXV, part. III, p. 827.

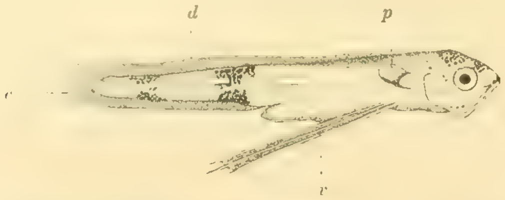

Fig. 124. Larva of *Molua molva*, about 5 times the natural size. After M'Intosh and Prince. *p*, the pectoral fin; *v*, the ventral fin; *d*, the dorso-caudal fin; *c*, the ano-caudal fin.

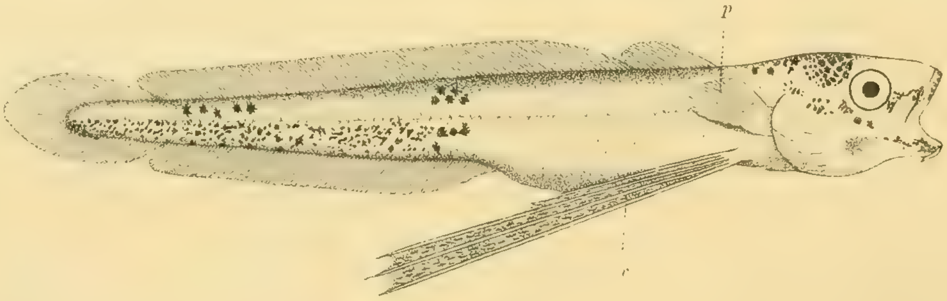

Fig. 125. Older larva of *Molua molva*, about 5 times the natural size. After M'Intosh and Prince. *p*, the pectoral fin; *v*, the ventral fin.

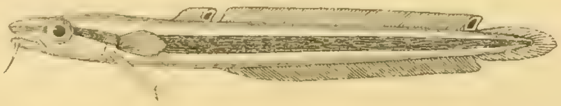

Fig. 126. Young specimen of *Molua molva*. Natural size. After M'Intosh.

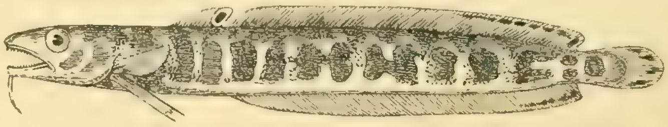

Fig. 127. Young specimen of *Molua molva*. Natural size. After M'Intosh.

These fins are inserted behind the perpendicular from the insertion of the minute pectoral fins, and their length is nearly half that of the body, but they contain only four rays. No barbel can be detected under the chin. The irregular transverse spots, formed by scattered pigment-cells, remind us of the more distinct transverse bands in the larvæ of the Cod. In a specimen 20 mm. long (fig. 125), taken at the same time of year, the barbel has begun to develop, and all the vertical fins are separated from each other; but the relative length of the ventral fins has only slightly decreased, and their insertion is still behind that of the pectoral fins. These changes of growth proceed from this point according to the rules laid down above, but a greater interest is attached to the subsequent changes of colour in the young Ling. At a length of 9 cm. (fig. 126) the body is marked with longitudinal stripes: "an olive-brown band passes from the tip of the snout in a line with the middle of the eye straight back round to the base of the caudal fin-rays. The pale ventral surface bounds it inferiorly, while dorsally a stripe with a beautiful opaline lustre runs from the tip of the snout over the eye backward to the base of the caudal rays. The latter band is opaque white on the tail, and it gives the fish a characteristic appearance. The dorsal line from the brain backward is distinguished by a narrow edge of dull orange or pale olive, and this brings out in relief the colours formerly mentioned." Both the dorsal fins display the black spot at the end. At a length of from 19 to 23 cm. at which period the fish is met with on rocky shores, its appearance is entirely changed (fig. 127). It is then marked with transverse spots of brown, both on the sides and on the back, the latter spots extending out over the basal part of the second dorsal fin; and the opalescent stripe of the preceding stage appears as a dentated band between the two rows of spots. The coloration was entirely different in two fresh specimens, respectively 40 and 50 cm. in length, which in November, 1889, were forwarded to the Royal Museum from Strömstad by Mr. C. A. Hansson. The smaller of these two specimens is the original of our figure (Plate XXVI, fig. 2). The ground-colour of the body is now reddish brown above and milk-white below. The orange or pale olive colour of the dorsal line in the fry has now extended over both the dorsal fins, which are edged with yellowish white, and each furnished with a black spot behind. This spot is more or less distinctly continued in a forward direction along the margin of the fin, below the white edge, by a dark band, which is either uninterrupted or broken up into small spots. The markings of the anal fin are like those of the second dorsal, but the ground-colour resembles that of the belly, though with a stronger tinge of gray. The caudal fin is of the ground-colour of the dorsal side, with a border broken up into spots, like that of the fins already described. On this fin as well as on the sides of the body and on the dorsal fins appear traces of the above-mentioned opalescent stripe of the juvenile stages, in the form of vermiform, violet and light blue transverse stripes, spots, and longitudinal bands. The pectoral fins are ashy blue on the inner part (the base), on the outer (distal) part orange-yellow. The ventral fins are of the same colour as the ventral sides. The barbel and the tip of the lower jaw are darker. In old specimens the ordinary coloration is much plainer, the upper parts of the body being grayish brown (chocolate gray) or greenish, the belly white and more or less grayish. The spots and bands of the younger specimens grow fainter and fainter, only the white margin of the vertical fins becoming still more distinct; but in old specimens we sometimes find large black spots irregularly distributed over the body and the vertical fins, twice, three times, or four times as large as the eyes. Nilsson mentions a variety "strewn with scattered, round, black spots, of the size of large peas."

The internal organs resemble those of *Molua dipterygia*, but the abdominal cavity is somewhat shorter, extending back only to a line with the base of about the 12th or 13th ray of the anal fin, and the peritoneum is white. The pylorus is also situated further back, nearer the bottom of the stomach.

The Ling is one of the most important Scandinavian fishes. It is apparently most common on the coast of Norway, from the neighbourhood of Bergen north to Finmark; but to the south it is also the object of an important fishery. Its geographical range extends along the coast of Europe from the Murman coast — where, according to Mela, it is common — to the Bay of Biscay, where it is extremely rare. Moreau records the capture of one specimen off Arcachon and of another in the neighbourhood of the Spanish frontier. In the English Channel and round the shores of Ireland it is common. Off Iceland it is also fairly plentiful; but whether it occurs on the Atlantic coast of America, is as yet a doubtful question. Fabricius, it is true, includes it in his *Fauna groenlandica* (p. 148), and gives an Esquimaux name for it, but he had never personally seen it in Greenland. Duhamel states that the Cod-fishers on the coast of North America sometimes catch nothing but Ling; but as he adds that the Ling is fished for off Spitzbergen in particular, his authority for both statements seems to be far from trustworthy. On the coast of Spitzbergen there is no recorded instance of the occurrence of the Ling. In the official statistics of Newfoundland[a] and Canada[b] small catches of Ling appear; but neither Jordan and Gilbert nor Brown-Goode and his collaborators include this species among the fishes of America.

In the Baltic proper the Ling is wanting, but at its south-west corner, off Kiel, the species has been met with twice, according to Möbius and Heincke. In the Sound it is rare, but, according to Winther, has once been taken just north of Copenhagen. Off Kullen it is somewhat commoner, but its true habitat begins in the north of the Cattegat and the Skager Rack.

The Ling is really a deep-sea fish. The most numerous and the largest Ling are taken in more than 100 fathoms of water. There they lead, without doubt, a life of plunder, so greedy that under ordinary circumstances they do not even associate with each other. The strong teeth of the Ling are an unmistakable sign of this; and in its stomach proofs have been found of the greatest voracity. Fishes of all kinds — Sharks and Chimæræ, Cod and Whitings, Halibut and Dragonets, etc. — form the chief portion of its food, and that it chases and seizes them in their flight, appears from the fact that they are frequently found in its stomach with the heads turned forward. About 8 miles off Wick[c], in March, 1872, a Ling about 6 feet in length was taken which had in its stomach a Salmon 27 in. long. But crustaceans and starfish are also devoured by the Ling, which probably keeps to the bottom of the sea during the greater part of its existence. As in the case of the Cod, we have the most singular evidence of the voracity of the Ling. Off Brandon Head on the south-west coast of Ireland a Ling was once[d] caught that had in its stomach a pewter flask containing "two glasses of an ardent spirit." In another specimen a three-gill bottle, some Herrings, and a small Cod were found[a], together with several bits of parchment and sealing-wax. These last substances might suggest the conclusion that the fish had swallowed one of the bottles which are set adrift to ascertain the set of the ocean-currents, or perhaps one of those sad farewell letters written in the bitter hours of distress at sea.

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[a] See, for example, Bull. U. S. Fish. Comm., vol. V (1885), p. 71.

[b] L. c., vol. VI, p. 54.

[c] See Buckland, *Nat. Hist. Brit. Fish.*, p. 129.

[d] Bull. U. S. Fish. Comm., vol. V (1885), p. 78.

Its voracity renders the Ling an easy capture. The true Ling-fishery is carried on at the same time as the Cod-fishery and in the same manner (see above, p. 478). For this purpose the fishermen of Bohuslän betake themselves to the Jutland Reef or the Norwegian fishing-banks of Jæderen and Storeggen. The Scotch Ling-fishery is pursued on the largest scale off the Shetland Islands; but all round Great Britain and Ireland[b] this fishery is of no small importance. BUCKLAND estimated the annual value of the Ling-fishery off Stornoway at £16,000. According to statistical reports[c] in 1888 129,766 cwts. of Ling of a value of £47,646 were taken on the coast of Scotland, 66,785 cwts. of a value of £47,135 on the coasts of England and Wales, but on the coast of Ireland only 10,130 cwts. of a value of £4,863. One may compare these figures with the statement[d] of Mr. v. YHLEN, Inspector of Fisheries, that in 1879 19,620 Ling of a value of about 20,000 crowns (£1,100) were brought to Gothenburg Fish Market. However, the greater part of the catch in Bohuslän is comprised in the statistical reports under the head of *storsjöfisket* (Great Sea-fishery; Cod etc.). This fishery has been extended since 1884 to the Shetland Banks, and in 1888, according to Dr. A. H. MALM, the value of the catch at first hand was 658,763 crowns (£36,230). How great a proportion of this catch consisted of Ling, is uncertain, but it can scarcely have been more than $^1/_4$. In the Cattegat the true Ling-fishery (with great long-lines) is of still less importance, the catch being only some hundred kilogrammes per annum. Small Ling, known by the fishermen as *Långebarn* (Ling-child)[e], are, however, taken pretty often in shallower water with the seine. During the winter months, according to EKSTRÖM, a few large Ling ascend into shallower water and are taken on Haddock-lines.

The Ling spawns in spring and early summer, from April to June inclusive. It spawns in the open sea, and the eggs float about in the water. Like the family in general it is extraordinarily prolific. OLSEN estimates the number of its eggs at five millions. The ripe eggs are stated by M'INTOSH to be nearly $^1/_{10}$ of an inch in diameter.

During and immediately after the spawning-season the Ling, like other fishes, is hardly fit for food. The liver in particular, which at other times is of a handsome reddish white, during the spawning-season is red and worthless. During the rest of the year the flesh of the Ling is excellent and more highly esteemed than that of the Cod. It is cured in the same way as the latter for home use and exportation; but Skewered-Ling (*spillånga* = split and dried Ling) is prepared in a special manner. The split fish is stretched as hard as possible on skewers (*spilor*) at several parts of the body, and then hung up to dry. Ling is dressed for the table in the same way as other stockfish; but EKSTRÖM mentions another dish which the fishermen of Bohuslän call *Stamp*, and which is prepared as follows: the flesh of the Ling together with the liver is thoroughly boiled in salt water and then pounded (*stampad*) to a pulp, which is eaten with avidity.

GENUS **LOTTA.**

Two fully developed dorsal fins, one anal fin: the vertical fins separated, but the peduncle (finless part) of the tail in most cases very small, if not imperceptible. Ventral fins with 6—8 rays. Caudal fin rounded. Teeth in the lower jaw and on the head of the vomer, as well as on the intermaxillary bones, small and of uniform size, without canines. Branchiostegal rays 7.

This genus, which comes extremely near the preceding one, contains, as far as we know at present, only one species, but is spread over the fresh water of the northern parts both of the Old World and of the

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[a] DAY, *Fish. Gt. Brit., Irel.*, vol. I, p. 306.

[b] See OLSEN, *Piscatorial Atlas*, tab. 22.

[c] Fish. Trades Gazette, 12th and 26th Jan., 1889.

[d] Appendix to the Swedish Catalogue, Berlin Exhibition 1880.

[e] Cf., however, p. 230 above.

New. In the southern hemisphere it has an extremely near relation among the marine fishes—from the Straits of Magellan and the neighbouring waters — in the genus *Salilota*, which by the deeper form of the body and the larger scales forms a transition to the following genus (*Phycis*). NILSSON[a] was the first to distinguish *Lotta* from *Molua;* but like JENYNS[b] before him, he adopted the Linnaean specific name of *Lota*[c] as a generic name, instead of the older name of *Lotta*[d], which was introduced into the system by RISSO[e].

The most striking external difference from the preceding genus lies in the close approximation of the vertical fins, it being scarcely possible to detect any finless part of the tail even in middle-sized specimens of *Lotta*, as the caudal fin can hardly be described as distinctly divided from the second dorsal or the anal fin. The connexion is closest between the caudal fin and the second dorsal, and is so intimate that the last rays of the latter are generally set in the membrane that unites the two fins. This character also belongs, however, to the primary stages in the development of the Ling (cf. above, figs. 124 and 125), and in this capacity is an evident expression of the near relationship of the two genera, pointing to the common original forms in which the vertical fins were never differentiated. How near *Lotta* and *Molua* stand to each other in this respect, also appears from the fact that the distance between the tip of the tail (the middle of the base of the caudal fin) and the termination either of the second dorsal or of the anal fin is remarkably alike in both genera, varying between about 7 and 9 % of the length of the body, with the following averages:

Average in	*Molua dipterygia* 4 specimens	*Molua molua* 5 specimens	*Lotta lota* 5 specimens.
Distance between the tip of the tail and the end of the second dorsal fin in of the length of the body...	8.1	8.1	7.9
,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, anal ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ...	8.3	8.9	8.3

Thus we find from this table that the character in point — the absence in *Lotta* of the peduncle of the tail — is essentially due to the greater extension in a forward direction of the caudal fin with its supporting rays at the upper and lower margins of the tail.

In common with the preceding genus, on the other hand, and in contradistinction to *Merlucius*, *Lotta* is furnished with the pendulous barbel under the chin. During life this barbel projects more or less distinctly forward.

The covering of the body consist in *Lotta* of remarkably small, thin, round or roundish quadrangular scales, with almost central nucleus, and with the striation especially dense, but consisting almost exclusively of concentric striæ, the radiating striæ being present only in the form of short, small, dentiform processes on the outer side of the concentric striæ.

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[a] *Skand. Fn., Fisk.*, p. 579.

[b] *Man. Brit. Vert. Anim.* (1835), p. 448.

[c] The name is taken from RONDELET (*De Pisc. lacustr.*, p. 164).

[d] The name occurs in BELON, and is a Latinized form of the French *Lotte*, which was applied to a subgenus by CUVIER in 1817, and was not supplemented by the Latin *Lota* until 1829, or later than the appearance of RISSO's work. In CUVIER, however, the species is always called *Gadus lota*.

[e] *Eur. Mér.*, tom. III (1826), p. 217.

THE BURBOT (SW. LAKEN).

LOTTA LOTA.

Plate XXVI, fig. 1.

Body somewhat like that of Silurus; head compressed in front, anterior part of the body terete, hind part compressed. Distance between the tip of the snout and the beginning of the first dorsal fin more than 31 % of the length of the body, length of the head less than 68 % of this distance. Breadth of the interorbital space more than 21 % of the total length of the head or than 40 % of the postorbital length thereof. Greatest breadth (thickness) of the body more than 48 % of the length of the head or than 22 % of the distance between the anal fin and the tip of the snout. Coloration made up of black spots or mottled with black (dark brown) and in most cases confluent spots, on a yellowish green ground.

R. br. 7; *D.* 13[a]—15(16) 74[b]—79(85); *A.* 65[c]—75(78): *P.* 18—21[d]; *V.* 6—8; *C.* $x+20—39+x$; *Vert.* 58—62.

A: forma *vulgaris*, pinnis pectoralibus lineam verticalem ex initio pinnæ dorsalis primæ attingentibus vel transientibus, longitudine $^{13}/_{100}$ longitudinis corporis totius superantibus.

Syn. *Gadus* dorso dipterygio, ore cirrate, maxillis æqualibus, Art., *Gen. Pisc.*, p. 22; *Syn. Pisc.*, p. 38; *Silurus*, Id., *Spec.*, p. 107; Lin., *Fn. Suec.*, ed. I, p. 109.

Gadus Lota, Lin.. *Syst. Nat.*, ed. X, tom. I, p. 255; Retz., *Fn. Suec. Lin.*, p. 322; Pall., *Zoogr. R. Asiat.*, tom. III, p. 201; Cuv., *Règne Anim.*, ed. 2, tom. II, p. 333; Nilss., *Prodr. Ichth. Scand.*, p. 47; Bdt, Rzbg, *Medic. Zool.*, Bd. 2, p. 52, tab. VII, fig. 2, tab. VIII, fig. 3; Ekstr., Vet.-Akad. Handl. 1834, p. 43; Reuter, Sundman (*Lota*), *Finl. Fisk.*, fig. X.

Lota vulgaris, Jen., *Man. Brit. Vert. Anim.*, p. 448; Nordm., *Voy. Russ. Mér.* (Demidoff), p. 530; Kr., *Danm. Fiske*, vol. 2, p. 169; Sundev., Wright, *Skand. Fisk.*, ed. I, p. 170 (1845), tab. 41 (1842); Nilss., *Skand. Fn.*, *Fisk.*, p. 580; Hckl., Kn., *Süsswasserf. Östreich. Mon.*, p. 313; Gthr, *Cat. Brit. Mus.*, *Fish.*, vol. IV, p. 359; Sieb., *Süsswasserf. Mitteleur.*, p. 73; Lindstr., *Gotl. Fisk.*, Gotl. L. Hush. Sällsk. Arsber. 1866, p, 21 (sep.); Mgrn, *Finl. Fiskar* (disp. Helsingfors), p. 31; Blanchard, *Poiss. d. eaux douces Fr.*, p. 272; Coll., Forh. Vid. Selsk. Christ. 1874, Tillægsh., p. 115; ibid. 1879, No. 1, p. 67; Gigl., Espos. Intern. Pesca, Berlino 1880, Sez. Ital., Cat., p. 97; Bncke, *Fisch.*, *Fischer.*, *Fischz. O.*, *W. Preuss.*, p. 89; Mor., *Hist. Nat. Poiss. Fr.*, tom. III, p. 256; Day, *Fish. Gt. Brit.*, *Irel.*, vol. I, p. 308, tab. LXXXVII; Grimm, *Fish.*, *Hunt. on Russian Waters*, Intern. Fish. Exhib. London 1883, p. 11; Norbåck, Handl. Fiskevård, Fiskafvel, p. 369, bild 109; Lillj., *Sv.*, *Norg. Fisk.*, vol. II, p. 147.

Lota communis, Rapp, *Fisch. Bodens.*, p. 36.

Lota Linnéi, Malm, *Gbgs*, *Boh. Fn.*, p. 491.

Lota maculosa, Mela, *Vert. Fenn.*, p. 301, tab. IX.

B: forma *maculosa*, americana, pinn. pect. lin. vertical. ex init. p. dors. 1:mæ haud attingentibus, longit. $^{11}/_{100}$ longitudinis totius corporis haud superantibus.

Gadus Lota, Penn., *Introd. Arct. Zool.*, ed. II, vol. I, p. CCXCVII.

Gadus maculosus, Lesueur, Journ. Acad. Nat. Sc., vol. I, p. 83; Id. (*Molva*), Mém. Mus., vol. V, p. 159, tab. 16; Rich., *Fn. Bor. Amer.*, *Fish.*, p. 248; Bean (*Lota*), *Fisher.*, *Fish. Industr. U. S.* (Br. Goode), sect. I, p. 235, tab. 61.

Gadus compressus, Lesueur, ibid., p. 84; Storer (*Lota*), Mem. Amer. Acad. Arts., Sc., n. ser., vol. VI, p. 360, tab. XXVIII, fig. 4.

Gadus lacustris, Mitch., Amer. Monthl. Magaz., vol. 2, p. 244; Ltkn (*Lota*), Vid. Meddel. Naturh. For. Kbhvn, 1881, p. 256.

Molva huntia, Lesueur, Mém. Mus., vol. V, p. 161.

Lota inornata, De Kay, *N. York Fn.*, *Fish.*, p. 283, tab. XLV, fig. 145.

Lota brosmiana, Storer, Journ. Soc. Nat. Hist. Boston, vol. IV, p. 58, tab. V, fig. 1.

Obs. The numerous specific names which the Burbot has borne in the system, are an expression of its variableness. In recent times, however, even the American writers have not only united all the assumed American species into one, but also adopted Günther's opinion and united this species to the European and Asiatic form. Lütken proposed, however, to restore the distinction between the two forms, on the grounds that in a specimen of the American Burbot examined by him the tips of the pectoral fins did not extend to a line with the beginning of the first dorsal fin, a character which also appears in the best figure of this form, Todd's figure in Bean and Brown-Goode (l. c.). Whether this character is constant in the American Burbot, can hardly be decided from so few observations; but it may also occur in the Burbot of the Old World, as shown by a specimen 9 dm. long, which was taken in the River Yenisei by Nordenskiöld's expedition on the 16th of September, 1875. In this specimen the tips of the pectoral fins fall far short of the perpendicular from the beginning of the first dorsal fin, this being due to the fact that the latter fin is situated extraordinarily far back, at a distance from the tip of the snout equal to $37^{1}/_{2}$ % of the length of the body and more than 5 times the length of the base of this fin. This specimen differs, however, both from the drawing mentioned above and from the measurements of the American Burbot given by Richardson (l. c.), in the fact that the pectoral fins are of the average length normal in the Burbot of the Old World. Though the length of the pectoral fins is extremely variable — the variations extending in our Burbot between 13 and 21 % of the length of the body — but in the Old World we have never found it to be less than 13 %. On the other hand, the removal in a backward direction of the dorsal fins and a relative decrease in their length seem to be changes of growth that might well explain the difference maintained by LÜTKEN, or at least impair its validity. This is the reason why we have not considered it necessary either to refer the specimen from the Yenisei to the American form, or even to regard the two forms of the Burbot as entirely distinct from each other[a], though there is a possible chance that the purely Arctic Burbot of the Old World are allied in form to the American Burbot, for, according to COLLETT, there is a wide gap in the range of the Burbot in Norway. Our collections are not extensive enough to enable us to decide this question.

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[a] Sometimes 10—12, according to Krøyer and Günther.
[b] ,, 67—69, ,, ,, ,, ,, ,,
[c] ,, 60, ,, ,, Moreau.
[d] ,, 17 or 22, ,, ,, Kroyer and Sundevall.

In central Sweden the ordinary length of the Burbot is about two feet (600 mm.). In the south of Sweden it seldom attains this length. A Burbot 57 cm. long has been found to weigh 1,487 grammes, one 5 dm. long nearly 850 grammes, and a specimen 4 dm. long 425 grammes. Thus in these cases the weight increased in direct proportion to the cube of the length. The largest Burbot SUNDEVALL ever saw, was taken about 1840 in Lake Båfven in Södermanland, and weighed $12^{3}/_{4}$ lbs. (6,375 grammes). A Burbot 13 lbs. (6,460 grammes) in weight was caught in a trap (*ryssja*) in Kyrkviken off Lidingö, on the 7th of January, 1887. It is, however, only exceptionally that Burbot more than two kilogrammes in weight are found in Sweden. The species attains a much larger size in the Arctic regions. As we have mentioned above, the Royal Museum possesses a specimen 9 dm. long from the Yenisei; and DALL states, according to BEAN (l. c.), that in Alaska the Burbot attains a weight of 60 lbs. ($27^{1}/_{5}$ kgm.), which according to the proportion assumed above presupposes a length of 13 or 14 dm. Thus the Burbot in size rivals the Ling.

The skin is rather thick and uncommonly strong, almost like that of the Eel; and there are many points of resemblance between these two fishes. The scales are very small, as in the other species known by the fishermen as '*skin-fishes*'; but they are distinctly visible through the slimy epidermis, in which they lie flat and close together, each scale entirely enclosed in a follicle. They do not seem to be firmly attached, and may be easily extracted with a penknife or the point of a needle. In a fish 6 dm. long the largest scales are hardly $1^{1}/_{2}$ mm. in breadth. They cover the skin entirely, out over the snout and the fins, where they are, however, very small.

The head is small. In a middle-sized Burbot its length, including the whole gill-cover, is only about $^{1}/_{5}$ (21 to $19^{1}/_{2}$ %) of the length of the body. Its length seems to be more subject to individual variations than to changes of growth. Seen from above its appearance is parabolical, rounded in front. The upper surface is strongly depressed, flat, and smooth. The head may be expanded to a breadth much greater than that of the body, but when the jaws and the gill-covers are closed, it is much narrower than the forepart of the trunk. The eye is round and deeply imbedded in a rather oblong socket without distinct margin. In specimens between 22 and 90 cm. long the longitudinal diameter of the eye varies between about $18^{1}/_{2}$ and $11^{1}/_{3}$ % of the length of the head, between about 62 and 37 % (sometimes $35^{1}/_{2}$ %) of the length of the snout, or between 85 and 36 % of the breadth of the interorbital space. Its centre lies at about the end of the first third of the length of the whole head. The iris is dark brown with silvery inner margin and round pupil. The tip of the snout projects a little beyond the anterior margin of the upper jaw. The two nostrils on each side are rather small, at least the anterior ones, which lie about half-way between the eye and the tip of the snout, and have the prominent hind margin elongated into a soft, flat filament, about half as long as the eye or a little longer. The posterior nostril is generally distinctly larger, and lies half-way between the eye and the anterior nostril or nearer the former. Its margin is not raised, but the upper (inner) part thereof generally projects in a rounded shape over the opening, which thus becomes kidney-shaped. The barbel under the chin is longer than the eye. The cleft of the mouth extends below the anterior margin of the eye. The margin of the upper jaw is formed by the intermaxillary bones alone, which are not protrusile, but have their front margin set below and, as we have mentioned, a little behind the tip of the snout. The maxillary bones extend far behind the intermaxillaries, below the middle of the eye, to a distance from the tip of the snout of between 8 and nearly 10 % of the length of the body or 41 and 45 % of that of the head. The lower jaw is flat; its articulation lies somewhat behind the eye, and its length measures from $9^1/_3$ to a little more than 11 % of that of the body or from 47 to 54 % of that of the head. In front it is a little shorter than the upper jaw. The teeth are rather close-set, fine, and pointed, and form a broad, cardiform row on the intermaxillary bones and in the lower jaw, while on the head of the vomer they are set in a semicircular band. The palatine bones are toothless. There are no transverse folds (vela) within the mouth. The four pairs of branchial arches are furnished on the inside (in front) with a double row of tubercular, but only few gill-rakers, 5—7 on the first arch. The cards of pharyngeal teeth, the upper ones united into a roundish patch on each side, are composed of densely set, small teeth, and, here as in the preceding genus, we find a small patch of teeth on the third pair of epibranchial bones. The branchiostegal membrane is extended by seven large and thick, but only slightly flattened rays. It lies bare, is rather large and only slightly, if at all, incised at the middle (under the isthmus), where it forms a broad, free fold right across to the opposite side. The gill-openings are fairly large. The tongue is large and fleshy.

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[a] From BEAN's (l. c.) comparison between European and American Burbot it appeared that the number of the vertebræ was the only constant distinction between these forms; but KROYER states that the number of vertebræ in the European form is 21 + 37, and MALM found 22 + 40. In a skeleton in the Royal Museum we find 23 + 39.

In front of the vent the body is terete, and the belly more or less pendent; behind it strongly compressed laterally and shallower. The hind part of the anal aperture is situated at the middle of the length of the body, excluding the caudal fin, and the usual depth of the body at this point is about $^1/_6$ of the length to the tip of the tail. The least depth of the body, at the base of the caudal fin, is between about $4^1/_2$ (sometimes 4) and $5^1/_2$ % of the total length of the body or about 22 (sometimes 20) and 28 % of the length of the head. The sharper convergence of the dorsal and ventral profiles, which proved in the Hake to coincide with the beginning of the hindmost sections of the dorsal and anal fins, in the Burbot does not appear until we reach the beginning of the peduncle of the tail, and is sometimes almost imperceptible. The lateral line, which is broad and distinct, but only slightly depressed and often interrupted, runs from the sides of the occiput, in a slight curve, near the back, approaches the middle of the sides behind the vent, and advances in a straight line to the tip of the tail. All the fins have soft, branched, well-separated rays, clothed with a firm, thick skin, which is furnished with fine scales.

The first dorsal fin generally begins at the end of the first third of the total length of the body, and above the tip of the pectoral fins when laid back. The distance between it and the tip of the snout, which usually varies between $31^1/_2$ and $34^1/_2$ % of the length of the body, may sometimes be as much as $37^1/_2$ % thereof (cf. above, *Obs.*). It contains generally 13, seldom 10 or 11 or even 15 or 16 rays, most of which, at the middle of the fin, are of equal height, measuring in most cases about $^1/_3$ or $^1/_2$ of the greatest depth of the body, but sometimes even more than $^3/_4$ thereof[a]. The anterior and posterior rays are variously shortened, the latter sometimes missing. The incision which separates the two dorsal fins, usually goes right down to the back, and when the number of rays in the first fin is extraordinarily small, this is due to the absence of one or two rays at its termination. The length of the base of the first dorsal fin is about 8 or 9 % of that of the body, though it may sometimes sink to about 6 % thereof. The second dorsal fin is of uniform height and generally somewhat higher than the first. In most cases it contains about 75 rays, the first 2, 3, or 4 and the last 4 or 5 diminished in length. The distance between the fin and the tip of the snout varies between about 40 and 43 % (sometimes 46 %) of the length of the body, and the length of its base between about 45 and 47 % (sometimes 42 or even 41 %) of that of the body.

The caudal fin is divided from the dorsal and anal fins by an incision in the membrane, but in young and middle-sized Burbot the notch never extends down to the body, and in these specimens no distinct finless space (peduncle of the tail), at the dorsal margin at least, is ever to be detected. It is first in a Burbot of unusual size (age), 9 dm. in length, that we have found the peduncle of the tail distinctly marked above and below. When the fin is strongly expanded (as in the figure), it is perfectly round; but it is generally seen in a somewhat folded position, and is then oblong and rather pointed, as in the Eel. It contains about 41 rays, of which 5 or 6 above and below are shortened (supporting rays), but not so transformed as in most other fishes that have a distinct caudal fin. On account of the thick integument they are difficult to count. The length of the middle rays varies between about 6 and 7 % (sometimes 8 or 9 %) of that of the body.

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[a] One of the Royal Museum specimens from Lake Wetter, with comparatively large head, is further distinguished by the extraordinary development of the fins: the height of the first dorsal fin is 9·7 %, the height of the second dorsal fin 9·3 %, the height of the anal fin 6.2 %, the length of the pectoral fins 21·4 %, the length of the ventral fins 18·2 %, and the length of the middle rays of the caudal fin 9·1 % — in each case, of the length of the body (483 mm.).

The anal fin begins at a distance from the tip of the snout equal to about 45—48 % (sometimes 49 or even nearly 50 %) of the length of the body, and the length of its base measures about 45—47 % (sometimes 42 or even 41 %) of that of the body. Its rays, generally about 70[a] in number, are of the same structure as those of the second dorsal fin, but their height is only $^3/_4$ of that of the latter.

The pectoral fin is large and rounded. It usually measures $^2/_3$ of the length of the head, but in one specimen we have found it almost as long as the whole head. It is generally made up of 18—20 rays. Often, however, according to Sundevall, there are 22 rays on one side or on both, and sometimes, according to Kroyer, only 17. At about the 7th or 8th ray we find 3 or 4 of the same length. The anterior and posterior rays grow gradually shorter. The first is simple, and generally half the length of the fin.

The insertion of the ventral fin lies entirely in front of the base of the pectoral fin. The rays are 6 or 7 in young Burbot, but in old ones quite as often 8. The second ray is soft and thick, $^1/_4$ longer than the others, and somewhat separated from them. In young specimens it is almost as long as the pectoral fin, in old ones distinctly (as much as $^1/_4$) shorter. The first ray is as long as the third and free at the tip.

The coloration, which is densely variegated with yellow and black, intensifies in a high degree the repulsive, Amphibian-like appearance of this fish. It is extremely variable, however: sometimes plain, dark blackish gray, sometimes lighter with only small spots of black on the upper part of the body. The relationship to the Ling is expressed by the collection of the black pigment into a more or less continuous band along the margins of the vertical fins. In spite of all the irregularity in the distribution and confluence of the spots we can generally trace a longitudinal band on the cheeks and snout. The inner (hind) surface of the pectoral fins is bluish. The belly and the ventral fins are generally pale and whitish, but sometimes only slightly lighter than the sides of the body. The fry seem always to be of a plain, dark colour.

Of the internal organs we may give the following particulars. The liver is rather large, reddish white, set on the left side, and undivided. A rather small lobe projects on the right side and covers the gall-bladder[b]. The peritoneum is white. The stomach, which forms an immediate continuation of the œsophagus, extends along only slightly more than $^2/_3$ of the abdominal cavity, and is furnished internally with 7 large longitudinal folds, which disappear when it is distended. Only one side, the side from which the pyloric part starts, is smooth and contains small, dense, digitate glandules, hardly a millimetre in breadth. The pyloric part originates on the under side of the stomach, in a line with the tip of the liver, not far from the bottom of the stomach. It is small and narrow, but thick-walled and firm. It is continued in a forward direction by the intestine, which at the very beginning has two bunches, one on each side, of 20—24 appendages, irregularly united at the base into a smaller number of ducts. The intestine soon bends back to the anal region, whence it returns forward, again to bend back to the vent. It is of uniform thickness, only the last portion (the rectum) being somewhat wider, closed by a valve (like a *valvula coli*), and furnished internally with five or six, not very distinct, longitudinal folds. The spleen lies at the hind part of the middle coil of the intestine. The ovaries are coalescent behind, with a common orifice, which opens behind the vent. They are hung in a distinct mesenterium or fold of the peritoneum. The ripe eggs are flame-yellow and rather small, 0·8—1 mm. in diameter, but exceedingly numerous, forming a mass of considerable size. Hermaphrodites are not so very rare; one specimen of this kind was described as early as 1800 by Professor Pipping of Åbo[c]. The air-bladder is fairly large and firm, lying close to the spinal column. It is somewhat compressed at the middle, grows wider anteriorly, and ends in front in two lobes, or with two obtuse corners or short ramifications, which occupy the anterior elongations of the abdominal cavity beside the dorsal column and the occiput. The kidneys form a fairly large, roundish, gray-brown reddish mass behind the air-bladder and the vent. They have only small, not very distinct prolongations in front below the spinal column. To the left side of this mass we find the urinary bladder, which is large and saccate, and is discharged behind the genital aperture.

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[a] In one young specimen, however, we have counted 89.

[b] According to Bean (l. c.), Dall found in male Burbot from Alaska two or even three, distinct gall-bladders, opening into a common gall-duct.

[c] Vet.-Akad. Handl. 1800, p. 33, tab. I, fig. 1.

The Burbot is the only fish of this family that lives in fresh water; but in its entire structure, as we have seen, it comes extremely near the Ling and other true marine fishes. It is spread over a fairly wide portion of the globe, namely almost the whole of Europe, the north of Asia, and North America. From its range we see that it is really a northern fish; and it seems to attain the highest point of its development in the lakes and rivers that discharge themselves into the Arctic Ocean. In America, however, it goes as far south as the 37th degree of latitude, but in Europe scarcely beyond the 45th. Even in the large lakes of Lombardy it is common, according to GIGLIOLI. In Russia, according to GRIMM, the Burbot is found everywhere in fresh water, with the exception of the rivers that flow into the south of the Caspian Sea. In central Europe it grows less and less plentiful further west, until in Great Britain it may be described as rare, while in Ireland it is never found. In Scandinavia too, it is principally an eastern and northern fish, which in Norway, according to COLLETT, is entirely wanting in the diocese of Bergen and along the greater part of the west coast. Throughout the fresh water of Finmark, on the other hand, it is common. This is also the case in Swedish Lapland, at Karesuando, Juckasjärvi, and Quickjock for example[a]. In Jemtland the Burbot is one of the fishes that go highest up the fells[b]. In central Sweden it seems to be more plentiful than further south, and it is one of the species brought to Stockholm in the greatest quantity during the greater part of the year. It is said occasionally to descend from Lake Wener, where it is common, into the River Gotha when the locks are opened[c]. According to the reports sent in to the Fisheries Commission of 1881[d] the Burbot occurs throughout the whole of Sweden[e], and in the District of Örebro attains a length of 35 in. (89 cm.) and a weight of $26^1/_4$ lbs. (11·9 kgm.). In the rivers and lakes of the Scanian plain and the Danish islands it is rare. FEDDERSEN[f] gives several instances of the occurrence of the Burbot in Jutland, and in the Elbe it is common[g]; but in Laaland and Falster, according to this author, as well as on Bornholm, it is wanting. KRØYER, however, once saw a very large specimen in Bornholm, and the species occurs in several of the lakes and streams of Gothland[h], as well as in the brackish water of the Baltic. It attains its maximum size in the regions where it is most plentiful, exceeding the average size at the northern limit of its range, but in Scania apparently smaller in every case.

Its favourite haunts are the lakes with clear water and a stony bottom, but it is also found often on a clayey bottom and in the larger, more sluggish streams and rivers. Though it does not live in the sea, it is met with at several spots in the Baltic island-belts where the water is only slightly salt and therefore abounds chiefly in fresh-water fishes.

During the greater part of the year the Burbot frequents deep spots. It is only towards the beginning of winter and during the spawning-season that it joins in a general migration to shallower water. It is rather sluggish, never collects in shoals, and never appears at the surface, but always hugs the bottom, hiding itself among stones, sunken logs, the roots of trees etc., where it lies still, preferring to await its prey than to seek it. Its capacity of speedy motion is shown, however, by its power of seizing other fishes. According to a statement made by Mr. GJÖBEL, a Burbot in Lake Wener is known to have swum 13 miles ($21^1/_3$ km.) in a night. It was recognised by a fish-hook in its mouth. Few other fishes have so supple a body and, in consequence thereof, such Eel-like or serpentine movements, and not many are so tenacious of life. The Burbot lives long after it is taken out of the water, without the surface of the body drying, this being apparently due to the copious secretion of mucus. The fishermen tear off the isthmus to kill the fish, an operation which is known as 'slaughtering the Burbot.' This is done on account of their strange belief that the fish would otherwise eat its own liver, which is considered the best part of it.

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[a] Cf. too WIDEGREN, *Handl. o. Upplysn. rör. Sveriges Fiskerier*, I, p. 41 (Aftr. ur Handl. rör. Landtbr., 24:de delen).

[b] See OLSSON, Öfvers. Vet.-Akad. Förh. 1876, No. 3, p. 138 and 1882, No. 10, p. 51.

[c] MALM, l. c.

[d] Underdånigt Betänkande med Förslag till ny Fiskeristadga m. m., Stockh. 1883, Bil. III, p. 156.

[e] In these reports it does not appear as an inhabitant of Gothland or of Blekinge; but its occurrence in the former locality is recorded by LINDSTRÖM (l. c.) and in the latter by GOSSELMAN (*Zool., Bot. Iakttag. inom Blek.*, disp. Lund 1864. p. 5).

[f] Naturh. Tidskr. Kbhvn, ser. 3, vol. XII, p. 75.

[g] KRØYER, l. c.

[h] LINDSTRÖM, l. c.

The Burbot is one of the most voracious fishes. It devours almost everything that comes in its way, live or even decomposed. It seems to live chiefly on small fishes, insects, worms, and the like, and in particular on fish-roe. It haunts the spawning-places of other fishes, and does great damage there by devouring the roe after its deposition. It can also swallow comparatively large fishes. A Burbot $22^{1}/_{2}$ in. (57 cm.) long which Sundevall examined in the month of December, was found to have swallowed a Pike $11^{4}/_{5}$ in. (30 cm.) in length. The head of the latter, which lay bent in the strongly distended stomach of the Burbot, at the extreme end of the abdominal cavity, was, with the exception of the teeth, almost digested, while the caudal fin projected in a crushed condition between the teeth of the Burbot.

In central Sweden the spawning-season of the Burbot begins in January and apparently proceeds during the whole of February. The fishermen state that the young Burbot spawn earlier than the older ones. To the north of Lapland the spawning-season is said to begin later. The spawning-place is chosen in shallow water with a bottom of sand or clay. These spots are known by the fishermen as 'Burbot-ridges' (*lakåsar*). In Lake Wetter, where according to Widegren the spawning commences at the beginning of February, but according to others not until March, the Burbot is stated not to ascend towards the shore or to the shallowest parts of the lake to spawn, but to remain in deep water, generally at a depth of 30 fathoms[a]. The roe is deposited separately and lies loose at the bottom. There are two kinds, one yellow, the other clear and almost colourless, but artificial fertilization has succeeded in both cases. The great fecundity of this fish is shown by the fact that Cederström computed the number of eggs in a female to be about 160,000, Sundevall about 180,000. Benecke states the number at about a million, Norbäck at about five millions. The segmentation of the yolk begins in about 24 hours; after 15 or 16 days the eyes begin to appear in the egg, and a day or two after small star-like pigmental spots may be seen on the surface of the embryo. At the same period the pulsation of the heart (15—50 beats per minute) is distinctly visible. The revolutions of the embryo within the egg become also distinct. After the lapse of three weeks from the impregnation the roe begins to hatch, but the period of hatching, strictly speaking, begins apparently at the end of four weeks[b]. The new-hatched fry, scarcely 3 mm. long, are always sharply curved in front; but many specimens are found which seem to be prematurely hatched and lie quite in a ring. The latter move but seldom, and only in a circle; some of them are further developed after some time, but others die soon. The specimens which are straight at the tail (fig. 128), are fairly active. They swim with a quivering movement of the body, generally up towards the surface, whence they sink motionless towards the bottom. While swimming they move the pectoral fins rapidly. Even after 30 days fry only slightly more than 3 mm. long are found. The subsequent development also proceeds slowly. At the age of one year the Burbot is only 90—120 mm. long, according to Norbäck, and is not capable of reproducing its species until four years old.

Throughout Sweden this fish is called *lake*. The names of *stenlake* (Stone Burbot) and *lerlake* (Clay Burbot) refer merely to the nature of the bottom on which the fish is taken. On the Baltic coast, however, the former name is also applied to the Viviparous Blenny (*Enchelyopus*), to which the Burbot has some resemblance. The small Burbot too, a few years old, which are generally of dark colour, and may often be found on the shore under the stones in a foot of water, are often called *stenlakar*.

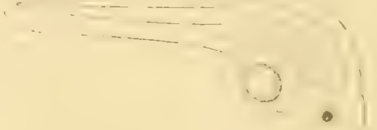

Fig. 128. New-hatched young specimen of *Lotta lota* (taken at the beginning of April, 1855), hardly 3 mm. long. After Sundevall.

The Burbot ranks among the most delicious fishes, though the elaborate method in which it is prepared for table, where it appears as a kind of ragoût (Sw. *stufvad lake* = *Lotte à la Villeroi*), no doubt contributes to its reputation. The flesh is white and firm. The liver is considered an especial delicacy. The older writers state that the roe is unwholesome[c], but in Sweden it is eaten freely without any evil results. In many places it is made into a palatable kind of caviare. The Burbot caught in Lake Siljan has long[d] been most highly praised for its excellence. As the Swedish proverb says:

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[a] See Landtbr. Akad. Tidskrift 1863, p. 212.

[b] According to Norbäck not until after two or three months.

[c] Cf. Kroyer, l. c., p. 183 and Day, l. c., p. 310.

[d] O. Siljerström-Larsson (sub præs. A. Grönwall), *Siljan* (disp. Upsaliæ 1730), p. 35

"Hiälmare Giädda, Siljans Laka, Ulo Lax,
Äro bland bästa fiskar uti sjögar tags."[a]

Several parts of the Burbot are used by the Swedish peasants, and also, according to Pallas, by the Ostiacs[b], as medicinal remedies. The oil which flows spontaneously from the liver, is employed as eye-salve; and the pyloric appendages, which are known by the peasants as *lakeklo* (Burbot-claws), are dried and powdered, the powder being taken in doses of a teaspoonful as a preventative of ague. The skin is wrapped, as soon as it has been flayed, round cracked glass vessels. When dry it adheres firmly to the glass, keeping the pieces together and rendering the vessel watertight. The Ostiacs make it into clothes. When rubbed with fat or oil it becomes semi-transparent, and is said to be used by the Russian peasants to glaze their windows. The air-bladder may be employed, in the form of isinglass, as glue.

The methods of catching Burbot are various but simple, as this fish is by no means cautious or cunning. It is taken most generally and in the greatest quantity in traps, either of the ordinary description (see p. 33, fig. 7), or *hanging-traps*, which are sunk in a hole in the ice and hung there vertically (with the top upmost). Sometimes too, single traps (*mjärdar*, see p. 32, fig. 6) are set at the bottom. In spring, as soon as the ice has broken up, the Burbot is also taken with long-lines, which are generally baited with Pope (*Acerina cernua*), the most tempting bait and that most easily procurable at this season. In summer it is caught on standing-hooks, in which case the bait should also be sunk to the bottom. During winter the so-called *lakskifva* (Burbot-disk) is used, a plate of lead in the shape of a fish and furnished with several hooks, with which the Burbot is struck. This disk also appears in another form — called *rot* (*råt*) or *lakekäx*, and common on the shores of Lake Wetter and in Vermland — which consists of a spike with four hooks projecting in opposite directions (in a cross), and is not unlike a grapnel. On the shaft just above the hooks or a little further up, the fisherman fastens a bit of Burbot-roe wrapped in a piece of muslin, or a small fish. This tackle is let down through a hole in the ice. The fisherman keeps plucking the hook upwards as soon as it reaches the bottom, and two or three Burbot, allured by the bait on the hook, may often be struck and drawn up together. When the Burbot makes its way to the shores, a habit we have mentioned above, it is *stunned* (*döfvad*). This is done in the following manner: the fisherman, armed with nothing but an axe, walks slowly and cautiously on the clear, new ice near shore, and when he sights the Burbot, which keeps close under the ice, he brings down the axe-head heavily just above the head of the fish. The latter is thus stunned, and lies helpless at the same spot, while the fisherman quickly breaks a hole in the ice and secures his catch. Of course, this last method is feasible only on very shelving shores. (Sundevall, Smitt.)

Genus **PHYCIS.**

Two fully developed dorsal fins, one anal fin: the vertical fins distinctly separated (a distinct peduncle of the tail). Ventral fins with three rays, but apparently with only one, filamentous, and branched. Caudal fin truncate or rounded. Cardiform teeth of uniform size (without canines) on the intermaxillary bones, in the lower jaw, and on the head of the vomer. Branchiostegal rays 7.

The great inconstancy in the number of rays in the ventral fins of the preceding genus contrasts it most sharply with the genus *Phycis*, in which these rays have suffered considerable reduction in number, but in adult specimens have attained a length in most cases even relatively greater than that which otherwise characterizes the larvæ of these fishes. In comparison with the three preceding genera, which *Phycis* resembles in the arrangement of the vertical fins, this genus is distinguished by the deeper, more compressed form of the body in adult specimens. During youth, however, the types are in this respect similar, or at least very nearly so.

The genus *Phycis*, itself one of the deep-sea fishes, is the centre of a group consisting of several other forms that belong to the abyssal zone, and compose series of forms with different directions of development, but so continuous that the limitation of the genera is extremely difficult, if it be even possible to suggest a natural system for this purpose. From Cuba, St. Helena, Madeira, and New Zealand we have *Physiculus*, without vomerine teeth and with more numerous rays in the ventral fins than *Phycis*, though their number varies between 7 and 3. *Uraleptus*, from the Mediterranean and Madeira, is a *Physiculus* with canine teeth set in a row outside the smaller jaw-teeth. *Haloporphyrus*, which occurs in the Mediterranean and the Atlantic, from Portugal down to the Southern Hemisphere, is a *Phycis* with reduced number of rays in the first dorsal fin. *Antimora*, from the Southern Hemisphere and the Atlantic south of Newfoundland, is a *Haloporphyrus* with elongated snout, a character which it possesses in common with the majority of the *Macruridæ*, and with the anal fin almost divided into two sections, a point which reminds us of *Merlucius*. Thus the *Phycis* type is extremely variable.

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[a] "Pike of Hiälmare, Burbot of Siljan, Salmon of Uleå, Are among the best fishes caught in lakes." Hiälmare is a lake in central Sweden, Siljan a lake in Dalecarlia, and Uleå a river in Finland. Tr.

[b] The Ostiacs are a people of Finnish extraction that inhabit the country between the Ural Mountains and the River Obi and the neighbourhood of the Yenisei. Tr.

The history of the fry approximates *Phycis* to the following genus[a]. Young specimens about 30—35 mm. long (fig. 129) are of a silvery, Mackerel-like colour, resembling the fry of the Rocklings. The four or three rays of the long ventral fins are united by a broad, black-pigmented membrane, as in the fry of the Ling.

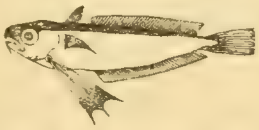

Fig. 129. Young specimen of *Phycis blennoides*, natural size. After FACCIOLA. Il Naturalista Siciliano, Anno II (1882), p. 27.

The scaly covering of *Phycis* is variable, but always better developed than in the preceding genera of this family. The concentric striæ (raised ridges) of the scales are finely but unevenly crenulated, and for the most part run parallel to each other, most of them (the outer ones) extending to the margin of the scale both in front and behind, which is the case in front with all of them. The nucleus, which lies near the hind extremity of the scale, is extremely narrow and elongated, and is continued forward in a groove to the extreme front margin of the scale, only the inner concentric striæ being thus continuous behind the nucleus. Round the latter we also find either an irregular network of fine striæ at the hind part of the scale, or a trace of this network in the form of fine transverse striæ between the concentric ones. In *Phycis* the lateral line also runs over true scales, not, as in the preceding genera of this family, with its pores opening in the bare skin. The fine grooves radiating towards the anterior margin are more distinct and more numerous in the scales of the lateral line than in the others.

In one species of this genus (*Phycis regius*) ALEXANDER AGASSIZ, according to BROWN-GOODE and BEAN[b], has observed a faculty of giving electric shocks, though according to these writers this power is possessed by the species only when it lives in very deep water. Special electric organs, however, have not been detected, and the electric sensation may probably be explained by the vibration caused in the entire body of the fish by the violent contraction of the large muscles.

DELAROCHE[c] and SØRENSEN[d] have described the air-bladder of *Phycis mediterraneus*. It is divided by two transverse contractions into three parts, internally communicating with each other, the first of which projects at the top into a pair of lateral horns attached to the upper end of each of the clavicular bones, and is furnished with a pair of transverse muscles at the anterior part of its wall, one on each side. From this structure SØRENSEN concludes that in *Phycis mediterraneus* the air-bladder is an organ of sound.

RONDELET[e] was the first to give this genus its name, for in ARISTOTLE[f] φυκὶς was certainly some other fish: "the only marine fish of which it is stated that it makes a bed in which to give birth to its young." The name was introduced into the modern nomenclature of science by ARTEDI[g] and BLOCH-SCHNEIDER[h]. The Swedish name of *Bartelfisk* (Beard-fish) was bestowed upon the genus by FRIES in the first edition of this work (p. 77).

The genus contains seven species[i], five of which belong to the Mediterranean and the European side of the Atlantic. The Scandinavian fauna contains only one of them.

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[a] LÜTKEN, Vid. Meddel. Naturh. Forh. Kbhvn 1881, p. 252: AGASSIZ, *Young Osseous Fishes*. Proc. Amer. Acad. Arts, Sc., vol. XVII, p. 296, tab. VIII, figs. 2 and 3; FACCIOLA, Il Naturalista Siciliano, Anno II (1882), p. 25; EMERY, Mitth. Zool. Stat. Neapel, Bd. 6, p. 159.

[b] Bull. Mus. Comp. Zool., Harv. Coll., vol. X, p. 204.

[c] Ann. Mus. D'Hist. Nat. Paris, XIV (1809), pp. 193 and 196.

[d] *Om Lydorganer hos Fiske*, p. 156, tab. IV, fig. 59.

[e] *De Pisc.*, Lib. VI, cap. X, p. 186.

[f] *De Anim.* Lib. VIII, cap. XXX.

[g] *Gen. Pisc.*, p. 84; *Syn. Pisc.*, p. 111. Hence the *Blennius Phycis* of LINNÆUS, *Syst. Nat.*, ed. XII, tom. 1, p. 442.

[h] *Syst. Ichth.*, p. 56.

[i] 11, if we include *Læmonema*.

THE GREAT FORKED BEARD (SW. BARTELN OR KUMRILLEN).

PHYCIS BLENNOIDES.

Plate XXV, fig. 2.

First dorsal fin in adult specimens much higher than the second, the third or the fourth ray being elongated like a filament. Scales of the body so large that a transverse row from the first dorsal fin to the lateral line contains only 4—6 scales. Length of the lower jaw greater than the postorbital length of the head and more than half the total length thereof. Breadth of the interorbital space less than $^3/_7$, *least depth of the tail at most about* $^1/_3$ *(34 %), of the length of the lower jaw. Length of the base of the anal fin less than the distance between this fin and the tip of the snout, and the distance between the insertion of the ventral fins and the beginning of the anal fin at least about* $^3/_5$ *of the length of the base of the latter fin. Coloration above of a more or less light chocolate colour, below whitish with a dash of violet and on the belly nearly white. Vertical fins blackish at the margin, as well as nearly the whole surface of the pectoral fins. Ventral fins red. Branchial cavity and the posterior part of the pharynx, as well as the peritoneum, blackish.*

R. br. 7; *D.* 8—10|57[a]—63; *A.* 53—57[b]; *P.* 15—19; *V.* 3; *C.* $x+15-18+x$; *Lin. lat.* 105—108[c]; *Vert.* 50[d].

Syn. *Barbus major* (*Great forked Beard*) JAGO apud RAY, *Syn. Meth. Pisc.*, p. 163, fig. 7; PENN. (Forked Hake), *Brit. Zool.*, tom. III, p. 170 (ed. 1776), tab. XXXI. *Merlu barbu*, DUH., *Pêches*, part. II, sect. I, p. 147, tab. XXV, fig. 4.

Gadus Blennoides, BRÜNN, *Ichth. Marsil.*, p. 24; BL.-SCHNEID. (*Phycis*), l. c.; CUV., *Règn. Anim.*, ed. I, tom. II, p. 217; NILSS., *Prodr. Ichthyol. Scand.*, p. 49; GTHR, *Cat. Brit. Mus.*, vol. IV, p. 351; STEIND., Stzber. Akad. Wiss. Wien, Math. Naturw. Cl., LVII I (1868), p. 708; COLL., Forh. Vid. Selsk. Christ. 1874, Tillægsh., p. 114; ibid. 1879, No. 1, p. 67; N. Mag. Naturv. Christ., Bd. 29 (1884), p. 83; MALM, *Gbgs, Boh. Fn.*, p. 490; WINTH., Naturh. Tidskr. Kbhvn, ser. 3, vol. XII, p. 32; MOR., *Hist. Nat. Poiss. Fr.*, tom. III, p. 264; DAY, *Fish. Gt. Brit., Irel.*, vol. I, p. 303, tab. LXXXV, fig. 2; STORM, N. Vid. Selsk. Skr. (Trondhj.) 1883, p. 35; LILLJ., *Sv., Norg. Fisk.*, vol. II, p. 156; HANSEN, *Zool. Dan., Fiske*, p. 78, tab. IX, fig. 10.

Gadus bifurcus, WALB. (ex PENN.), *Ichth. Art.*, pt. III, p. 137.

Gadus albidus, GMEL., (ex BRÜNN.) *Syst. Nat. Lin.*, ed. XIII, p. 1171.

Blennius gadoides, LACÉP., *Hist. Nat. Poiss.*, tom. II, p. 484.

Phycis furcatus, FLMNG, *Brit. Anim.*, p. 193; KR. (*Phycis*), *Danm. Fiske*, vol. I, p. 609, vol. II, p. 214; MALM, Gbgs Vet., Vitt. Samh. Handl., H. 2 (1851), p. 111; NILSS., *Skand. Fn., Fisk.*, p. 584; THOMPS., *Nat. Hist. Irel.*, vol. IV, p. 187.

The maximum length of the Great Forked Beard is apparently between about 6 and 7 dm.[e] The body is comparatively deep and compressed — reminding us somewhat of *Gadus luscus*, though more elongated — especially in its hind part, where the depth is also seemingly increased by the loose skin which covers the bases of the dorsal and anal fins. In adult specimens the greatest breadth (thickness) of the body is only $^2/_3$—$^1/_2$ of its depth at the beginning of the anal fin, and the thickness at the middle of the body, vertically above the middle of the base of the anal fin, is only about $^1/_4$ of the depth at the same point. In young specimens, however, we meet with different proportions, more resembling those which we have observed in the form of the body of the genera immediately preceding the present one. In specimens 18 cm. long (from the Mediterranean) the body is almost terete in front, and at the perpendicular from the middle of the base of the anal fin — where in young examples of this species we find a round black spot on the dorsal fin — the thickness is about $^1/_3$ of the depth. In general (except in gravid females) the curves of the dorsal and ventral contours are the same, but at the occiput we often find a perceptible depression, which may perhaps be ascribed to the violent contraction at death of the dorsal muscles. In adult specimens — with the exception of gravid females — the greatest depth of the body occurs at the beginning of the first dorsal fin, and measures about 21 % of the length of the body or a little more than (sometimes equal to, and in young specimens even less than) the depth at the beginning of the anal fin; and the least depth of the body (tail) varies between $3^1/_2$ % (in youth) and 4 % (in old specimens) of the length of the body or between 27 and 34 % of the length of the lower jaw.

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[a] Sometimes 54, according to DAY.

[b] „ 51, „ „ LILLJEBORG.
„ 58, „ „ DAY.

[c] 112, according to DAY.

[d] 15 + 35, according to MALM.

[e] In Trondhjem Fjord, according to COLLETT, STORM obtained a specimen 665 mm. long. THOMPSON mentions an Irish specimen 25 in. (635 mm.) in length.

In full-grown specimens the head partakes of the general compression of the body. Above it is flat or slightly convex, and its flat sides, the cheeks, are almost parallel to each other. The length of the head varies with age[a] between about 22 and 23 % of that of the body. The eyes are rather oblong and fairly large, the longitudinal diameter of the orbits varying with age between about $6^1/_2$ and 5 % of the length of the body or 30 and 22 % of that of the head. They are set in the second third of the head, though the length of the snout varies between about 28 and 33 % of that of the head, and the postorbital length of the head between about 42 and 50 % of the total length thereof. The nostrils are set in the last third of the snout, on about a level with the centre of the eye, the distance between them being about the same as that between the posterior one and the margin of the orbit. The anterior nostril, which is a small, round opening, is marked by a lobate elevation of the hind superior part of the margin; the posterior is twice as large and oblong, without any elevation of the margin. The tip of the snout projects beyond the margin of the upper jaw, and the latter in its turn beyond the tip of the lower jaw. The whole snout is soft and of a loose structure, this being due to the extensive development within it of the muciferous ducts of the system of the lateral line. The opercular apparatus is most like that of the Hake, with triangular, almost forked operculum. The suboperculum is thin but broad, and pointed at the top (behind); it lies under and fills the deep incision in the hind posterior margin of the operculum, while the inner part of its truncate, anterior (lower) end touches the interoperculum, which is thicker but narrower. Thus the margin of the entire opercular apparatus is somewhat incised at this point. The preoperculum, with its broad margin (to receive the muciferous duct) is rectangular but rounded at the angle. The branchiostegal membranes are united into a collar underneath, but this collar terminates posteriorly almost vertically below the centre of the eye. The jaws resemble those of the Cod. The maxillary bones extend back to the perpendicular from the hind margin of the pupil, the intermaxillaries being a little shorter and reaching only to the perpendicular from the anterior margin of the pupil. The distance between the tip of the snout and the hind extremity of the maxillary bones is greater than the postorbital length of the head and more than half the total length of the head, but less than the length of the lower jaw, which varies between 60 and $53^1/_2$ % of the length of the head or between 33 and 28 % of that of the base of the anal fin. The postorbital length of the head is thus always less than the length of the lower jaw, but increases with age even in this relation, from about 70 to 90 or 91 %. The length of the barbel under the chin is somewhat less than that of the eye. The teeth are most like those of the Burbot, being small and of uniform size, but set in a dense card in the lower jaw and on the intermaxillary bones and in a curve, somewhat pointed in front, on the head of the vomer. The palatal folds behind the jaw-bones are narrow but distinct, at least in the lower jaw. The tongue is flat and broad, with a narrow, free tip and margin. The gill-rakers, 14 or 15 in number on the first branchial arch, are well-developed, but not of any great length. The pharyngeal teeth resemble the jaw-teeth.

The first dorsal fin begins at a distance from the tip of the snout that varies with age between about 25 and about 29 % of the length of the body, and it terminates close to, but quite distinct from the beginning of the second dorsal fin. When erected it has the form of an almost right-angled triangle with the right angle at the hind corner and with the shortest side (the base) measuring about 6 or 7 % of the length of the body. As a rule the first three rays are simple, and the third ray is elongated into a filament about twice as long as the fourth ray, which, like the others, is branched. The first ray is about half as long as the second, which is somewhat shorter than the fourth. The variations in this respect are, however, considerable, and the elongated ray sometimes projects only slightly above the others, its length varying, even in adult specimens, between about 10 and 17 % of that of the body. The second dorsal fin begins at a distance from the tip of the snout of 32—36 % of the length of the body, and its base, taking into account the individual variations, measures between 51 and 53 % of this length. Its height is fairly uniform, but greatest (9 or 10 %

[a] Here and in the following relations the changes of growth are given as we have found them in specimens between 18 and 57 cm. long.

of the length of the body) in the posterior part of the fin, and the margin is incised just behind the middle of its length. All the rays — except the first, the first two, or the first three — are branched in full-grown specimens, though only indistinctly in the anterior part of the fin, and the ramification is scarcely perceptible in the thick, loose fin-membrane. The length of the peduncle (finless part) of the tail is about equal to its depth. The caudal fin is rather narrow, and sharply rounded at the hind margin, its median length varying between 13 and 10 % of that of the body. The anal fin is analogous to the second dorsal in form and structure, but is not so distinctly higher in the posterior part. It begins just behind the vent, the distance between its beginning and the tip of the snout being in young specimens about 43 %, in old as much as 50 %, of the length of the body. The length of the fin varies in different individuals between 43 and 40 % of that of the body, and its longest ray measures about $8^1/_2$—$6^1/_2$ % of the latter length.

The pectoral fins are obliquely pointed, and their length measures about $15^1/_2$—14 % of that of the body. The uppermost two or three rays are simple and the others branched. The fifth ray is the longest, but only slightly longer than the fourth, which in its turn is slightly longer than the third. The first ray is about half as long as the second, and the latter measures about $^2/_3$ of the third ray.

In the ventral fins, which until MALM's time (1851) were universally believed to consist of only one ray, the second ray is the longest, measuring in specimens of different ages from about 43 to 31 % of the length of the body, but varying in length to such an extent that it sometimes extends behind the beginning of the anal fin, and sometimes falls short of this point[a]. The length of the first ray is about $^3/_4$ of that of the second, and its tip — for almost half the length of the ray — is free from the latter. The third ray is united throughout its length to the second, the tip alone forming a small, indistinct break on the inner side of the fin, at a distance from the base of the fin equal to about $^1/_5$—$^1/_4$ of the length of the second ray. The position of the ventral fins is remarkably jugular, the fins being inserted almost in a line with the hind margin of the preoperculum and far apart from each other, on either side of the abdomen, which is rather flat at this point. The distance between the insertion of the ventral fins and the beginning of the anal fin increases with age from 25 to 32 % of the length of the body.

The covering of scales is dense, and clothes the whole body and the head to the snout, extending also over the vertical fins and the outside of the base of the pectoral fins. The scales are large, but imbricated to such an extent that only a narrow strip of the surface of each scale is externally visible behind the scale in front of it. In form they are rectangular, more or less oblong, and behind and in front more or less convex. In a specimen 57 cm. long the largest scales at the middle of the body and half-way up the sides are about 14 mm. long and $10^1/_2$ mm. deep, while the free part of each scale measures about 2 mm. Nearer the dorsal fin each scale is about 12 mm. long and 7 mm. deep, and projects about 3 mm. behind the scale in front of it.

The upper part of the body is light chocolate-coloured or reddish brown with a dash of gray, the lower part paler and shading into whitish. The cheeks and lower jaw are coated with a silvery colour, and the hind part of the body is tinged with violet, which becomes deeper back towards the base of the caudal fin and down over the greater part of the anal fin. The belly grows whiter and whiter, and is finely punctated with dark-brown, which colour also extends over the margins and outer parts of the vertical and pectoral fins, though the latter, like the first dorsal fin, are violet at the base. In young specimens a large, round spot of dark brown appears at about the middle of the second dorsal fin. The ventral fins are red with a dash of yellow and with the free tips of the rays white. The iris is pale yellow.

The internal organs are like those of the other Cod-fishes. The abdominal cavity is black, and extends to a line with the fourth or fifth ray of the anal fin. The pylorus originates near the hind extremity of the stomach. The pyloric appendages are numerous and long. The liver is large, and the two principal lobes are irregularly subdivided. The intestine first runs forward to a line with the insertion of the pectoral fins, then back to the anal region, again forward for the same distance as before, and finally back to the vent. In a female caught at the beginning of March, each of the ovaries is of about the same thickness as the stomach, and extends forward for about $^1/_4$ of the length of the abdominal cavity.

On the coast of Sweden the Great Forked Beard is extremely rare. Only three or four specimens are known to have been taken in Bohuslän. Two of these are preserved in Gothenburg Museum, and the Royal Museum has acquired through Mr. C. A. HANSSON a specimen 57 cm. long which was caught on a long-line at a depth of 130 fathoms, north of Helsö near Strömstad, on the 12th of March, 1887. The fisherman who handed over the specimen, stated, however, that the species was known and called *Kumrill.* It is more common to the south of Norway, up to the neighbourhood of Trondhjem, where it is called *Stenbrosme* (Stone Torsk) or *Skjælbrosme* (Scaly Torsk). Young specimens, however, have never been found on the Swedish coasts, and are at least extremely rare in Norway, if they occur there at all, for "all the specimens hitherto examined," says COLLETT, "have been full-grown or nearly so." Thus the true habitat of the Great Forked Beard does not lie in Scandinavia, and scarcely in British waters[a], but further south, in the Mediterranean. There it lives, says RISSO[b], "collected in large shoals, and seems to prefer very deep spots with a soft bottom, where it is taken in considerable numbers all the year round, on long-lines." The young specimens, which RISSO regarded as a distinct species (*Phycis Gmelini*), are said to lead a solitary life among the seaweed in shallower water (in the littoral zone). The food of the species consists of crustaceans and fish. The females, according to RISSO, are full of roe towards the end of spring and during summer. "The flesh," he says, "is wholesome, juicy, and of good flavour all the year round: it is one of the foods recommended by physicians for weak and impaired digestions."

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[a] In the original of our figure the second ray of the right ventral fin measures 180 mm., of the left 152 mm.

GENUS **ONOS**.

Two dorsal fins, though the anterior one is broken up into a row of free, filamentous rays: one anal fin: the vertical fins distinctly separated (a distinct, finless peduncle of the tail). Ventral fins with 6[c]*—8 rays. Cardiform teeth on the intermaxillary bones, in the lower jaw, and on the head of the vomer. Branchiostegal rays 7*[d].

RISSO[e] was the first to give this genus a special name, and he selected for this purpose the name which the Greeks applied to the Codfishes in general. The genus has long been known, however, by the name of *Motella,* which was given it somewhat later[f] by CUVIER, but which he expressly declared to be merely a division of his subgenus *Lota* of the genus *Gadus.* In form these fishes come nearest to the Burbot and the Lings, and are therefore known in Swedish as *skärlångor* (Rock Lings), in Danish as *havkvabber* (Sea Burbots).

The chief character of the genus lies in the singular structure of the first dorsal fin, which is broken up into a number of free, filamentous rays, united by the fin-membrane only at the base — which lies hidden in a deep groove in the dorsal margin. The fin-membrane, however, is generally comparatively thick and skin-like. The rays are usually of uniform height and short, with the exception of the first, which is more or less elongated, sometimes considerably so. Another striking characteristic of these fishes is the equipment of the snout with barbels. Not only is the lower jaw, like that of so many other Codfishes, furnished with a barbel under the chin, and the hind margin of the anterior nostrils raised and elongated into a similar filament; but in this genus the tip of the snout may also be furnished with one or two similar barbels. In one species we find on each side of the snout, on a level with the last-mentioned barbels, a row of three shorter, rudimentary excrescences of this nature, growing on the dermal margin in which the free lower margin of the preorbital bones is continued forward.

The scales are small and thin, in texture almost exactly like those of the Burbot, with fairly central nucleus and dense (but during youth fewer and more scattered), concentric striæ, denticulated at the margin. The whole surface on each side of the nucleus is longitudinally cut off, however, by a middle groove, which grows somewhat broader towards the ends of the scale, and is broadest at the anterior (inserted) end, which is also notched. The lateral line opens into scattered (comparatively few) ducts, which do not entirely pierce the scales.

The fry of these fishes (Plate XXVII, fig. 2) are quite different from the old specimens, especially in coloration (though also in form) and habits. Their appearance resembles that of the Mackerel or Sand-eel, with a silvery lustre on the sides. The first dorsal fin, like the barbels, develops comparatively late; but the ventral fins are long, though with few rays and with the outer part black, in the early stages. The forepart of the body and the head are laterally compressed, and sometimes, according to LÜTKEN, each of the temples is furnished with two spines. The eyes are as usual comparatively large in these young specimens, which, however, possess the characteristics of the genus. During the summer-months they live in companies or shoals at the surface, and are often cast ashore or into the fishing-boats by the waves. They are also eagerly devoured by sea-birds and fishes-of-prey. The older specimens keep to the bottom, leading a more solitary life and hiding themselves under rocks, stones, and seaweed, or roving about on the clayey bottom. The older specimens are remarkably tenacious of life, while the fry die almost as soon as they are taken out of the water. All these differences, which also vary in their duration, one example of a species retaining a juvenile character longer than another, gave rise to the establishment of a distinct genus, *Couchia*[a], to receive the young forms, an error which was first corrected by MALM[b] and subsequently by LÜTKEN[c].

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[a] Though it undoubtedly spawns there, for DAY gives a figure, in the natural size, of a young specimen $3\frac{4}{5}$ in. long.

[b] *Eur. Mér.* T. III, p. 224.

[c] Exceptionally 5.

[d] Exceptionally 6.

[e] *Eur. Mérid.*, tome III, p. 214 — *Onos.*

[f] *Règne Animal.* ed. 2, tom. II, p. 334.

The genus *Onos* contains 10 known species[d], one from Japan, one from the south of the Indian Ocean, seven from the Atlantic, the Arctic Ocean, and the Mediterranean, and one from the Mediterranean alone. The species which belong to the Scandinavian fauna may be distinguished as follows:

A: Longitudinal diameter of the eyes more than 30 % of the postorbital length of the head. A single barbel at the very tip of the snout .... *Onos cimbrius.*

B: Longitudinal diameter of the eyes less than 30 % of the postorbital length of the head.

  a: Length of the head, even after the *Couchia*-stage, more than 23 % of that of the body[e]. Margin of the snout furnished with several pairs of barbels *Onos septentrionalis.*

  b: Length of the head, after the *Couchia*-stage, less than 23 % of that of the body.

    α: Length of the lower jaw more than half that of the head. Tip and margin of the snout without barbels .... *Onos tricirratus.*

    β: Length of the lower jaw less than half that of the head. Tip of the snout furnished with a pair of barbels .. .. *Onos mustela.*

THE FOUR-BEARDED ROCKLING (SW. FYRTÖMMADE SKÄRLÅNGAN).

ONOS CIMBRIUS.

Plate XXVII, fig. 1.

Four barbels: one at each of the anterior nostrils, one on the tip of the snout, and one on the chin. Length of the head in full-grown specimens (after the Couchia-stage) less than 20 % (about 17—19 %) of that of the body. Longitudinal diameter of the eyes more than 30 % (about 32—40 %) of the postorbital length of the head, which is less than the distance between the tip of the snout and the hind extremity of the maxillary bones. Length of the lower jaw at least $\frac{1}{2}$ *(50—61 %) of that of the head.*

R. br. 7; *D.* 45—51[f]; *A.* 39—43[g]: *P.* 15—17; *V.* 5—6; *C.* 30—31; *Vert.* 52(57[h]).

Syn. *Gadus cimbrius*, LIN., *Syst. Nat.*, ed. XII, tom. I, p. 440; STRUSSENFELT, Vet.-Akad. Handl. 1773, p. 22, tab. 2, fig. A; BL. SCHN. (*Enchelyopus cimbricus*), *Syst. Ichth.*, p. 50, tab. 9; RETZ. (*Gadus*), *Fn. Suec. Lin.*, p. 323; NILSS. (*Motella*), *Prodr. Ichth. Scand.*, p. 48; SCHAGERSTR., Physiogr. Sällsk. Tidskr., p. 302; PARN., Mem. Wern. Nat. Hist. Soc., vol. VII, p. 449, tab. XLIV; KR., *Danm. Fiske*, vol. II, p. 198; EKSTR., Gbgs, Vet., Vitt. Samh. Handl., Ny Tidsf., H. I, p.

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[a] Called *Ciliata* by COUCH (Loud. Mag. Nat. Hist. vol. V, p. 15), and subsequently altered to *Couchia* by THOMPSON (*Nat. Hist. Irel.*, vol. IV, p. 190).

[b] Skand. Naturf. M. Kbhvn 1873, Ber., p. 384; *Gbgs*, *Boh. Fn.*, p. 495.

[c] Vid. Meddel. Naturh. For. Kbhvn 1881, p. 239.

[d] Besides these GÜNTHER has described *Onos macrophthalmus* (from 80—90 fathoms, off the Hebrides) and *Onos Carpenteri* (from 180 fathoms, between the Shetland and Faroe Islands), young, three-bearded Rocklings, of each of which only one single specimen is known.

[e] In the Mediterranean, according to MOREAU, *Onos tricirratus* may also possess this character.

[f] 53, according to STORER.

[g] 48, ,, ,, ,,

[h] According to MALM.

39; NILSS., *Skand. Fn., Fisk.*, p. 587; GTHR., *Cat. Brit. Mus., Fish.*, vol. IV, p. 367; LINDSTR., *Gotl. Fisk.*, Gotl. L. Hush. Sällsks. Årsber. 1866, p. 21 (sep.); MALMN, Öfvers. Vet.-Akad. Förh. 1867, p. 263; COLL., Forh. Vid. Selsk. Christ. 1874, Tillægsh., p. 116; ibid. 1879, No. 1, p. 67; MALM, *Gbgs, Boh. Fn.*, p. 498; WINTH., Naturh. Tidskr. Kbhvn, ser. 3, vol. XII, p. 33; LTKN, Vid. Meddel. Naturh. For. Kbhvn 1881, p. 235; DAY, *Fish. Gt. Brit., Irel.*, vol. I, p. 316, tab. LXXXIX, fig. 1; JORD., GILB. (*Onos*), Bull. U. S. Nat. Mus., No. 16, p. 797; MÖB., HCKE (*Motella*), *Fisch. Osts.*, p. 83; STORM, Norsk. Vid. Selsk. Skr. Trondhj. 1883, p. 36; LILLJ. (*Onos*), *Sv., Norg. Fisk.*, vol. II, p. 175; HANSEN, *Zool. Dan., Fiske*, p. 85, tab. X, fig. 5.

Gadus Mustela, STRUSSENF., l. c., p. 24, tab. II, fig. B.

Motella caudacuta, STOR., Proc. Bost. Soc. Nat. Hist., vol. III, p. 5; Mem. Amer. Acad. Arts, Sc., n. ser., vol. VI, p. 361, tab. XXIX, fig. 1; GILL (*Rhinonemus*), Proc. Acad. Nat. Sc. Philad. 1863, p. 241. Cf. GOODE et BEAN, Proc. U. S. Nat. Mus. vol. 3 (1878), p. 348.

Couchia Edwardii, COUCH, Journ. Lin. Soc., Lond., Zool., vol. IX, p. 38.

In Scandinavia, according to LILLJEBORG, the Four-Bearded Rockling sometimes attains a length of about 41 cm.[a]; but its usual length varies between 20 and 38 cm. The largest specimen ever taken on the coast of Great Britain was 35 cm. long, according to DAY. In adult specimens the form of the body is comparatively elongated, this species being generally the most slender of our Rocklings, and the depth at the beginning of the anal fin measuring on an average only about 12 % of the length of the body. According to the rule of the generic changes of growth, however, this proportion increases with age, after the *Couchia*-stage, and may sometimes be nearly as much as 14 %. The least depth of the body, in front of the base of the caudal fin, varies between $3^1/_2$ and $4^1/_2$ %, or eventually nearly 5 %, of its length. Even in front too, the body is only slightly terete. The head is generally somewhat depressed — all these remarks apply to adult specimens — but its section is sometimes nearly square. At the beginning of the second dorsal fin the thickness is about $^3/_4$ or $^3/_5$ of the depth; and posteriorly the thickness decreases more and more, measuring at the beginning of the anal fin about $^2/_3$ or $^1/_2$ of the depth. The extreme end of the tail is almost ribbon-shaped. The elongated form of the body is further enhanced by the comparatively great length of the caudal fin, the middle rays of which measure more than the postorbital length of the head.

The points in the form of the head that are characteristic of this species, are the depth of the snout, the size of the eyes, and the comparative narrowness of the head itself. With its tumid cheeks (thick masticatory muscles) and when the gill-covers are expanded, the head is broad and may be called depressed; but, until the fish has attained a length of about 3 dm., the breadth of the head is less than half its length. The quadrilateral, more or less square form of the transverse section of the head is persistent in the snout, at least for a lengthy period, though in old specimens it finally becomes more depressed. Simultaneously with this change of growth the position of the eyes is also altered. Originally they are quite lateral, set vertically and parallel to each other, but they eventually acquire a somewhat upturned position and diverge backwards. The tip of the snout projects beyond the upper lip and the still shorter lower jaw, and the length of the snout is on an average $^1/_4$ of that of the head. The eyes are oblong, their longitudinal diameter measuring on an average $19^1/_2$ % of the length of the head. The nostrils are set on the sides of the snout, on about a level with the centre of the eye, the anterior pair rather near the beginning of the sharply rounded tip of the snout, the posterior half-way between the tip of the snout and the eyes. The barbel projecting behind each of the anterior nostrils extends, when laid back, at least to the centre of the eye and sometimes even a little behind the eye. The unpaired barbel is the shortest, measuring only about half the longitudinal diameter of the eye. The barbel under the chin is somewhat longer, but measures less than the length of the eye. We must remember, however, that during life these barbels, as well as the fleshy lips, are very mobile, and the unpaired barbel is said to be capable of elongation and retraction, like the tentacles of a mollusk. The mouth is rather large, its corners lying in old specimens vertically below the hind margin of the eyes, and the maxillary bones extending back to a distance from the tip of the snout that is always more than half (about $53^1/_2$—62 %) of the length of the head. The length of the lower jaw is always less than this distance, and varies with age between 50 and about 59 % of the length of the head. The postorbital part of the head is generally longer than the lower jaw, but shorter than the distance between the tip of the snout and the hind extremity of the maxillary bones. Its length seems to be more subject to individual variations, and measures between $52^1/_2$ and $57^1/_2$ % of the length of the head. The gill-openings are wide, for the dermal fold formed by the inferior union of the branchiostegal membranes is free from the isthmus forward to the anterior end of the hyoid bone, and the upper corners of the gill-openings lie far up the sides, on about a level with the upper margin of the eyes. The tongue is broad and thick, with the free margin and tip thin. The pointed and curved jaw-teeth form a card in most cases distinct, on the front part of the intermaxillary bones; but this card grows considerably narrower behind, and sometimes, in old specimens, even at the very front of the maxillaries, we find only two or three rows within the outermost row, which is made up of larger but more scattered teeth. In the lower jaw the innermost row is composed of larger teeth, and in front of this row we generally find only one row of smaller teeth. The card of teeth on the head of the vomer contains small teeth, which gradually disappear with age. In young specimens this card is crescent-shaped, convex in front, or triangular, with several rows of teeth, but in old specimens there are only one or two rows of vomerine teeth. The breadth of the card is at most about $^1/_3$, and eventually no more than $^1/_5$, of the longitudinal diameter of the eye. The pointed, conical, pharyngeal teeth together form a broad, oval card on the upper pharyngeals on each side; and the lower pharyngeals, which are scaphoid in shape, and somewhat curved at the middle, the breadth being $^1/_4$ of the length, are furnished with 5 or 6 rows of similar teeth. The gill-rakers are short and scattered, like tubercles, the first branchial arch being furnished with 8—10 pairs. During life the whole of the branchial cavity and the cavity of the mouth with the tongue are bluish black.

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[a] WINTHER mentions a specimen from Liim Fjord of a length of 63 cm.. This statement is not confirmed, however, either by [illegible] or by HANSEN, and is probably due to a slip of the pen or an error of the press.

The first dorsal fin — which in this genus consists of about 50 free, filamentous rays, which vibrate during life, and are without interspinal bones — is distinguished in the Four-Bearded Rockling by the remarkable length of the first ray, which in the females measures about $^1/_3$ of the length of the head, in the males up to at least 87 % thereof. In the males its tip, when laid back, may thus extend some way behind the beginning of the second dorsal fin. The distance between the beginning of the first dorsal fin and the tip of the snout is 15—17 % of the length of the body, and the length of its base measures about $8^1/_2$—10 % of this length or $45^1/_2$—55 % of that of the head. This fin is always separated by a distinct interval from the second dorsal fin, which begins at a distance from the tip of the snout that measures about $26^1/_2$—29 % of the length of the body. The base of the latter fin extends nearly to the caudal fin, and measures about $57^1/_2$—59 % of the length of the body. All the rays of this fin, except the first one, are branched at the tip, the first 4—6 gradually increasing in length and the last 4 or 5 growing gradually shorter. The other rays are of fairly uniform length, but somewhat longer in the posterior part of the fin, the length of the longest ray varying between about $7^1/_2$ and 9 % of that of the body. The caudal fin is sharply rounded when expanded, lanceolate when folded. The anal fin resembles the second dorsal, but is much shorter and distinctly lower. It begins at a distance from the tip of the snout of about 41 % (38—43 %), its base measures about 45 % ($43^1/_2$—49 %), and its longest ray about $6^1/_2$ % (6—7 %) of the length of the body.

The pectoral fins are oval and obtusely pointed, with the middle rays longest and the first two simple. They are fairly long, measuring about 13 % ($11^1/_2$—16 %) of the length of the body. The ventral fins are set far apart, almost below the beginning of the first dorsal fin or a little further forward, at a distance from the beginning of the anal fin that measures about $21^1/_2$—26 % of the length of the body. The first two rays, sometimes the first three, are free at the tip. The length of these fins is about 8 % (7—10 %) of that of the body.

The anal aperture, with a small anal papilla behind it, lies just in front of the beginning of the anal fin.

The scales are small, but densely imbricated, and extend — growing smaller and smaller forwards and outwards — over the whole of the head, leaving only the branchiostegal membrane and the lips naked, and over the entire membrane of the second dorsal and the caudal fins, as well as over the hind part of the membrane of the anal fin. The outer surface of the pectoral fins is also clothed with scales to an extent of about one-third; but the ventral fins are naked. The lateral line is sometimes scarcely distinguishable: in the original of our figure, a female, no lateral line could be traced while the specimen was fresh. It runs from the upper corner of the gill-opening, parallel to the dorsal edge, until it reaches the perpendicular from about the vent. At this point it descends, at first not quite to the middle of the sides of the tail, but afterwards coming nearer and nearer this position, and advances straight to the middle of the base of the caudal fin. Its scattered pores, about 30 in number, are either simple or sometimes, in its anterior part, ramified in the form of a cross or a rosette.

The coloration on the back is a more or less dark, reddish brown (blackish brown, according to Lilljeborg; brownish gray, according to Kroyer), growing lighter and lighter down the sides towards the white belly, which is finely punctated with brown. As shown in our figure, irregular clouded spots of brown also occur on the sides of the tail. On the sides, and still more distinctly on the snout, the head shades into blue, more and more closely approximating to the colour of the cavity of the mouth. The first ray of the first dorsal fin is blackish blue. The other vertical fins are for the most part grayish blue or ash-gray, the margin of the second dorsal fin, the hind margin of the caudal fin, and the anterior part of the margin of the anal fin shading into yellow or red. All these fins are marked with bluish black, in a manner that strongly reminds us of the coloration of the corresponding parts of the body in *Molua dipterygia*. This is the case with the black spot at the ends of the second dorsal and the anal fins — the most persistent chromatic character in specimens preserved in spirits — and the black colour of the upper and lower margins of the caudal fin also call to mind *Molua dipterygia*. The coloration of the pectoral fins, consisting principally of bluish black, suggests the same comparison, though these fins are grayish blue at the base. The ventral fins are also grayish blue. The iris is silvery white, with a brassy lustre.

The abdominal cavity is short in comparison with that of the Cods. It terminates posteriorly in a line with the beginning of the anal fin. The peritoneum is black. The liver lies almost entirely on the left side, and does not extend further back than to about the middle of the abdominal cavity or to the beginning of the last third thereof, while the bottom of the stomach lies at about the middle of the cavity. The pyloric part is almost cylindrical, and runs in a forward direction, a little in front of the bottom of the stomach, on the lower side of the latter. It is sharply contracted in front and furnished there, at its termination, with 7—9 comparatively large appendages. The intestine runs first forward almost to the diaphragm, then back to the hind extremity of the abdominal cavity, again forward within the first coil, and finally back to the anal aperture. The spleen is of a three-sided, prismatic form, and is situated behind the bottom of the stomach. The urinary bladder is long and often lies in angular curves. The testes are divided into lobes, as in the Cods, and the ovaries of normal structure. The air-bladder is pointed in front, and extends along the posterior two-thirds[1] of the upper wall of the abdominal cavity.

Such is the appearance of the Four-Bearded Rockling in its adult state. Its earlier (*Couchia*) stage was first observed by Thomas Edward off Banff, and described by Couch (l. c.). The specimen was 41 mm. long, more elongated than the young of other species of the same size, and had longer and more pointed pectoral and ventral fins. The unpaired barbel was considerably longer than the nasal ones. The dorsal side was of a handsome, deep green colour, or the back itself yellow, with a narrow stripe of purplish blue bounding it from the lustrous, silvery white colour of the sides. These young specimens have subsequently been found at the surface of the sea by Möbius and Heincke off Heligoland.

The Four-Bearded Rockling was originally known only as a Swedish species and from the Sound. Schneider gives as its geographical range the Atlantic and (rarely) the Baltic. Kroyer obtained it from Lyngen Fjord in Norwegian Finmark, Malmgren from Öx Fjord. Parnell found it in the Firth of Forth. Since then it has been observed at several spots, though rarely, on the coast of Great Britain down to Cornwall. It seems to be commonest in Norway, where it has been met with in nearly all the fjords, in Christiania Fjord in particular. Here, according to Collett, it is taken on long-lines shot for Cod, and during the autumn months is almost daily brought to the fish-market of Christiania. On the coast of Bohuslän it is comparatively rare, and occurs principally in spring. Winther considers the Four-Bearded Rockling to be the commonest Danish species of the genus, and gives two instances of its entering Liim Fjord from the North Sea. In the Sound it does not penetrate south of Saltholm, to the best of our knowledge; but its range extends through the Great Belt, where it is taken generally in spring, to the west of the Baltic, where it has been found now and then off Flensburg, Kiel, and Travemünde. These are the only localities in the Baltic where the species is known, with the exception of Gothland, where, according to Lindström, it lives at a depth of 50—70 fathoms, and is occasionally caught in winter. Here it attains a size of at least 35 cm. In the west of the Atlantic the Four-Bearded Rockling was discovered in 1848 in Massachusetts Bay by Storer, and again met with by the Fisheries Commission of the United States in the same region "outside the 100-fathoms line."

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[1] Kroyer had met with examples of this species with much smaller air-bladder.

That the Four-Bearded Rockling is really a deep-sea fish, appears from the comparatively large size of its eyes; but it is now and then caught on Cod-lines and in shallow water, sometimes no more than 8 or 10 fathoms deep. Its stomach and intestine have been found to contain crustaceans (*Cuma*, *Idothea*, *Pontoporeia*, *Crangon*, *Palæmon*), Annelids (*Polynoe*), and mollusks (*Nucula*). Its food thus shows that it keeps to the bottom and among seaweed. Its spawning-season is not known with certainty; but the female, 312 mm. long, which has been the original of our figure, was taken by Mr. C. A. Hansson off Strömstad in July, 1889, and was full of roe, though this was still firm. Parnell's specimen was a female caught in June, and with rather more developed ovaries. To judge by these two specimens, the spawning-season occurs during summer or at the beginning of autumn.

The habits of the older specimens are but little known; but Edward kept five specimens of the fry in the *Couchia*-stage alive in an aquarium for a week. At first they were peaceably disposed among themselves, but joined in fiercely attacking a Goby that was their fellow-prisoner; and when it was dead, they turned upon each other. Edward also observed that they never raised the first ray of the first dorsal fin, but that, when the other fins were at rest, the filamentous rays of this fin kept up a continual vibration, which instantly ceased when the fish was frightened. The rostral barbel evidently served as a special organ of touch, and could be lengthened or shortened at will.

THE NORTHERN ROCKLING (sw. NORDISKA SKÄRLÅNGAN).

ONOS SEPTENTRIONALIS.

Fig. 130.

At least 11 barbels: one at each anterior nostril, a pair on the tip of the snout, three, short, lobate ones, the hindmost only tuberculate, on each side behind this pair, in the dermal fold that runs forward from the lower preorbital margin, and one under the chin. Length of the head in adult specimens nearly 25 % of that of the body. Longitudinal diameter of the eyes in full-grown specimens less than 30 % of the postorbital length of the head, this length being about equal to the distance from the tip of the snout to the hind extremity of the maxillary bones, but less than the length of the lower jaw, which is more than half that of the head. Least depth of the tail less than 30 % of the depth of the body at the beginning of the anal fin.

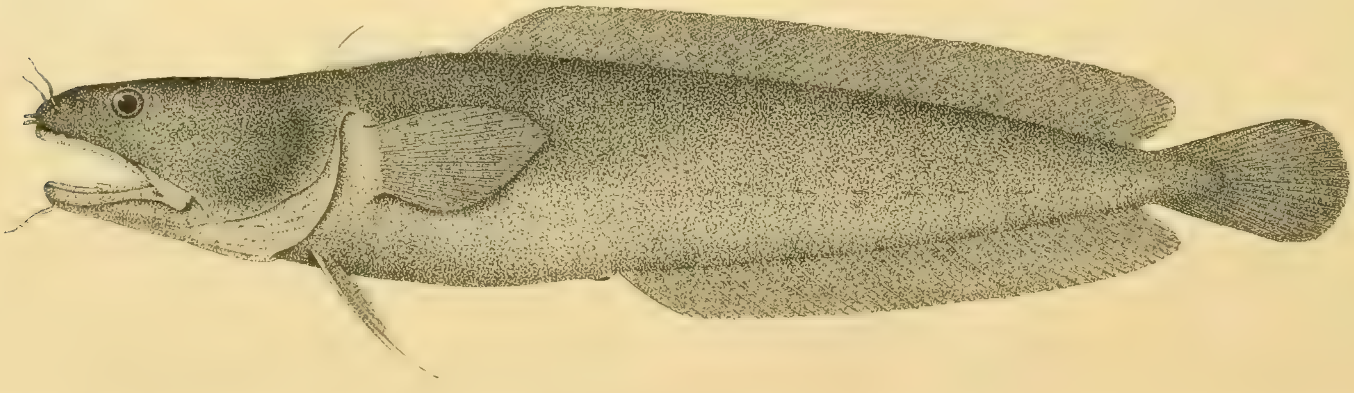

Fig. 130. *Onos septentrionalis* from Florö (Norway). Natural size. Specimen belonging to the Museum of Christiania University.

R. br. 7; *D.* 49—53; *A.* 41—43; *P.* 15—16; *V.* 7; *C.* 28—30.

Syn. *Motella septentrionalis*, Coll., Ann., Mag. Nat. Hist., ser. IV, vol. XV, p. 82; Forh. Vid. Selsk. Christ. 1874, Tillægsh., p. 117, tab. II; ibid. 1878, No. 4, p. 20; ibid. 1879, No. 1, p. 68; Id. (*Onos*), N. *Nordh. Exped., Zool., Fiske*, p. 138, tab. IV, figg. 35 et 36; Ltkn (*Motella*), Vid. Meddel. Naturh. For. Kbhvn 1881, p. 234; Storm, N. Vid. Selsk. Skr. Trondhj. 1883, p. 36; Coll. (*Onos*), N. Mag. Naturv. Christ., Bd. 29 (1884), p. 86; Lilli., *Sv., Norg. Fisk.*, vol. II, p. 172.

The Northern Rockling is known almost exclusively through Collett's researches, and, up to the present at least, only comparatively small specimens have been found. The largest specimen known is only 174 mm.

long. The species is distinguished in the first place by its large head and deeply-cleft mouth. The former is a character of age, which in this genus as in others belongs to the fry, but the latter is of entirely opposite signification, the gape being as a rule even relatively larger and more deeply cleft in old Rocklings than in young. The development of the numerous barbels is strictly to be regarded as a variation of the character of the Five-Bearded Rocklings, for we find two nasal barbels, two rostral ones, and one barbel under the chin, all of which in this species, too, are regularly set at their fixed places. Besides these, however, we find a row of more or less rudimentary barbels, more or less pointed, small dermal flaps or small, blunt dermal protuberances, situated like the rostral barbels in the dermal fold at the lower margin of the preorbital bones, which partly conceals the upper jaw and runs forward under the tip of the snout or a little above it. In Collett's type-specimen there are three of these rudimentary barbels on each side behind the rostral ones, but in another specimen he remarked one more barbel, situated "straight behind" (above the space between) these two barbels.

The head is distinctly depressed (broader than high: the greatest breadth equal to the length of the lower jaw). The body is fairly deep in front — in the type-specimen the depth at the beginning of the anal fin is 16 % of the length of the body; but behind the depth decreases more rapidly than is usual in the genus, the depth of the peduncle of the tail in the type-specimen being no more than $28^{1}/_{2}$ % of the depth of the body at the beginning of the anal fin. In all the specimens of the other Rocklings that we have been enabled to examine, this percentage has been more than 30.

The eyes are small, their longitudinal diameter being about $11^{1}/_{2}$ % of the length of the head and only slightly more than half the breadth of the flat interorbital space[a]. On account of the depression of the head they are turned obliquely upwards (at an angle of about 45°), and they lie almost vertically above the middle of the length of the upper jaw. The posterior nostrils lie somewhat farther from the eyes than from the anterior nostrils. The jaw-teeth form cards in the ordinary manner, but the teeth in the outermost row on the intermaxillary bones and in the innermost row in the lower jaw are more scattered and only slightly larger than the others. The breadth of the card of teeth on the head of the vomer is somewhat greater than the longitudinal diameter of the eye, and these teeth form an angle rather acute in front.

In COLLETT's type-specimen the distance between the first dorsal fin and the tip of the snout is nearly 23 %, and the base of this fin nearly 9 %, of the length of the body. The length of the first ray[b] is about equal to the breadth of the interorbital space[c] or to the least depth of the tail[d]. The distance between the second dorsal fin and the tip of the snout is $33^{1}/_{2}$ % of the length of the body, and its base measures about 52 % of the same length. The middle rays of the rounded caudal fin do not measure quite $^{1}/_{10}$ of the length of the body. The distance between the anal fin and the tip of the snout is 46 %, the distance between it and the base of the ventral fins 23 %, and the length of its base 40 %, of the length of the body. The length of the pectoral fins is $^{1}/_{8}$ of that of the body. The length of the ventral fins is contained about $7^{1}/_{2}$ times in that of the body.

The covering of scales leaves the greater portion of the snout naked, but extends forward on the forehead to a line with the posterior nostrils. The lateral line follows the same course as in the preceding species and contains about 20 pores.

The coloration, according to COLLETT, is plain grayish brown, without spots, slightly lighter on the ventral side than on the back. The specimen preserved in spirits is reddish brown, with the ventral side shading into gray. The inside of the mouth white. The iris blackish blue.

In his last account of the fishes of Norway COLLETT tells us that 9 specimens of this species are known at present, from the north and west parts of the Norwegian coast, from Öx Fjord in Finmark down to Florö off Stadt Promontory. The Museum of Copenhagen possesses a specimen from Greenland. The species was first discovered in 1873 during Professor SARS's dredging-operations; and of its habits nothing more is known than that it is met with in deep water, sometimes at least 50 fathoms in depth.

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[a] In a younger specimen COLLETT found the longitudinal diameter of the eyes to be $16^{2}/_{3}$ % of the length of the head, and their vertical diameter equal to the breadth of the interorbital space.

[b] 19·3 % of the length of the head.

[c] 20·0 % „ „ „ „ „ „

[d] 18·6 % „ „ „ „ „ „

THE THREE-BEARDED ROCKLING (SW. TRETÖMMADE SKÄRLÅNGAN).

ONOS TRICIRRATUS.

Fig. 131.

Only three barbels: one at each anterior nostril and one under the chin. Length of the head in adult specimens 20—22$^1/_2$ % of that of the body. Longitudinal diameter of the eyes in full-grown specimens less than 30 % of the postorbital length of the head, this length being greater than the distance between the tip of the snout and the hind extremity of the maxillary bones, and also (as a rule) than the length of the lower jaw, which is more than half the length of the head. Least depth of the tail more than 6 % of the length of the body, than $^1/_2$ the base of the first dorsal fin, than 19 % of the distance between the second dorsal fin and the tip of the snout, or than 45 % of the depth of the body at the beginning of the anal fin. Base of the first dorsal fin less than $^2/_3$, its first ray less than $^1/_4$, of the distance between it and the tip of the snout.

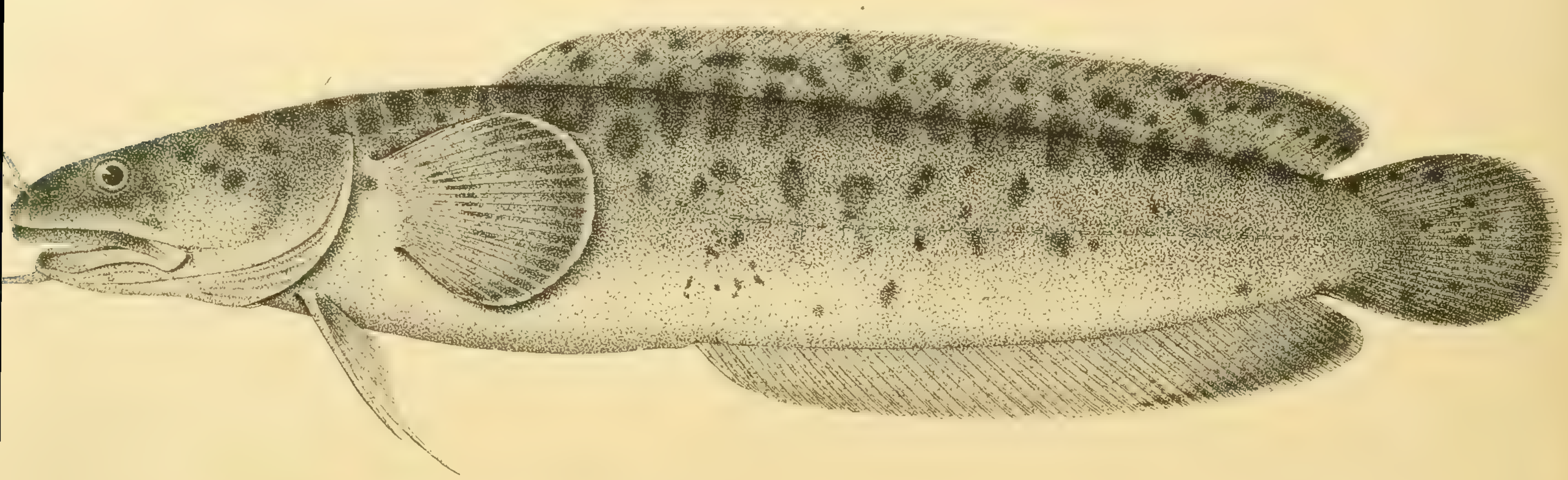

Fig. 131. *Onos tricirratus* from the island-belt of Gothenburg, 22nd Nov., 1886. $^1/_2$ the natural size. Specimen in the possession of Gothenburg Museum.

R. br. 7; *D.* (55) 58—60 (64)[a]; *A.* (45) 47—49 (54)[b]; *P.* 19—21[c]; *V.* 7[d]; *C.* 30; *Vert.* 48—49[e].

Syn. *Mustela varietas*, WILLUGHBY, *Hist. Pisc.*, p. 121; *Rockling, Mustela marina vulgaris* (1), JAGO apud RAIUM, *Synops. Pisc.*, p. 164, fig. 9; *Three Bearded Cod*, PENN., *Brit. Zool.* (1776), tom. III, p. 176, tab. XXXIII, No. 87.

Gadus tricirratus (p. p.), BRÜNN., *Ichthyol. Massil.*, p. 22; DONOVAN, *Nat. Hist. Brit. Fish.*, vol. I, tab. II; FLMNG, *Brit. Anim.*, p. 193; NILSS. (*Motella*), *Prodr. Ichth. Scand.*, p. 48; *Skand. Fn., Fisk.*, 586; GTHR (p. p. + *M. maculata*, p. p.), *Cat. Brit. Mus., Fish.*, vol. IV, pp. 365 et 366; OLSSON, Öfvers. Vet.-Akad. Förh. 1867, p. 650: COLL., Vid. Selsk. Forh. Christ. 1874, Tillægsh., p. 121; MOR., *Hist. Nat. Poiss. Fr.*, tom. III, p. 268; DAY, *Fish. Gt. Brit., Irel.*, vol. I, p. 317, tab. LXXXVIII, fig. 1.

Gadus argenteolus, MONTAGU, Mem. Wern. Soc., vol. II, p. 449; YARR. (*Motella*), *Brit. Fish.*, ed. 2, vol. II, p. 283; GTHR (*Couchia argentata*), *Cat. Brit. Mus., Fish.*, vol. IV, p. 363; DAY (l. c.), tab. LXXXIX, fig. 3.

Gadus Mustella, RISSO, *Ichth. Nice*, p. 120; ID. (*Onos*), *Eur. Mér.*, tom. III, p. 215.

Motella vulgaris, YARR., *Brit. Fish.*, ed. 1, vol. II, p. 186; ed. 2, vol. II, p. 270; STEIND. (p. p.), Stzber. Akad. Wiss, Wien, Math. Naturw. Cl. LVII, I (1868), p. 710; LÜTK., Vid. Meddel. Naturh. For. Kbhvn 1881, p. 235; COLL. (*Onos*), N. Mag. Naturv. Christ., Bd. 29 (1884), p. 87.

Motella quadricornis, KR. mpt., LÜTK., l. c., pp. 245—246.

Onos maculatus, LILLJ., *Sv., Norg. Fisk.*, vol. II, p. 164.

Obs. BRÜNNICH, it is true, has not given a description of this species definite enough to enable us to decide with any certainty whether he really distinguished between it and LINNÆUS's *Gadus mediterraneus*, and he was evidently doubtful himself on this point. Still, when he says that it is more common in the Atlantic on the coast of Cornwall than in the Mediterranean and the Adriatic, he undoubtedly refers principally to our species. BLOCH's description and figure (*Ausl. Fische*, Th. II, p. 100; pl. CLXV) are no less obscure; but the names of *Three bearded cod* in PENNANT and *Gadus tricirratus* in DONOVAN (1808) defend NILSSON's *Motella tricirrata*.

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[a] 55—57, according to DAY.
62—64, ,, ,, LÜTKEN.
50—60. ,, ,, MOREAU.
[b] 51—54, ,, ,, LÜTKEN.
45—50, ,, ,, MOREAU.
[c] 21—22, ,, ,, LÜTKEN.
16—18, ,, ,, DAY.
[d] Sometimes 8, according to LÜTKEN.
[e] According to GÜNTHER.

RISSO (*Eur. Mér.*) distinguished between three Mediterranean species of this genus (*Onos mustella*, *On. maculatus*, and *On. fuscus*), but based this distinction on the chromatic characters alone. COSTA (*Fn. Regn. Nap.*, *Pesci*, *Malacott.*, *Sottobr.*, pp. 17 and 39, tav. XXXVIII, bis) recognised only two, one (*Motella communis*) corresponding to RISSO's *Onos fuscus*, the other to the *Onos maculatus* of the latter and coinciding with LINNÆUS's *Gadus mediterraneus* (*Syst. Nat.*, X, tom. I, p. 255; *Mus. Ad. Frid.*, tom. II:di prodr., p. 60). The latter species was described by CANESTRINI (Arch. Zool., Anat., Fisiol., vol. II, p. 369, tav. XV—XVI, fig. 2) from the Gulf of Genoa, under the erroneous name of *Motella communis*. COLLETT, LÜTKEN, and LILLJEBORG give true form-characters to distinguish between two Mediterranean species, the one identical with the Three-Bearded Rockling, the other with LINNÆUS's *Gadus mediterraneus*. MOREAU, like RISSO, but on better grounds, distinguished between three Mediterranean species: *Motella tricirrata* (RISSO's *Onos mustella*), *Motella maculata* (*Onos maculatus*, RISSO), and *Motella fusca* (*Onos fuscus*, RISSO). On the chromatic character we can hardly pass any opinion, for the only specimens we have been enabled to examine were preserved in spirits[a]. The form-characters, on the other hand, show an extremely close connexion between the three species. In most characteristics *Onos fuscus* is an intermediate form between *Onos mediterraneus* and *Onos tricirratus*, thus impairing the validity and usefulness of these characteristics. This is the case for example with the difference pointed out by MOREAU in the length of the upper jaw from the tip of the snout to the hind extremity of the maxillary bones. In our specimens of *Onos mediterraneus* this length is exactly $^1/_2$, in the specimens of *Onos fuscus* $51^1/_2$—52 %, and in those of *Onos tricirratus* 53—nearly 58 %, of the length of the head. Again, as far as we can judge from our materials for examination, the breadth of the interorbital space in *Onos mediterraneus* is less than 30 %, in *On. fuscus* more than 30 but less than 33 %, and in *On. tricirratus* more than 35 %, of the postorbital length of the head. The length of the upper jaw in *On. mediterraneus* is less than 30 %, in *On. fuscus* more than 30 but less than 34 %, and in *On. tricirratus* more than 34 %, of the distance between the second dorsal fin and the tip of the snout. The length of the lower jaw in *On. mediterraneus* is less than 33 %, in *On. fuscus* more than 33 but less than 36 %, and in *On. tricirratus* more than 38 %, of the distance just mentioned. The length of the base of the first dorsal fin in *On. mediterraneus* is more than 74 %, in *On. fuscus* less than 70 but more than 66 %, and in *On. tricirratus* less than 63 %, of the distance between the first dorsal fin and the tip of the snout. *Onos fuscus* occupies this intermediate position in spite of the fact that, according to MOREAU, it never attains the same size as the two other species, a circumstance which is especially worthy of remembrance in the case of the specimens we have examined, among which the specimens of *Onos fuscus* are almost exactly equal in size to the youngest specimens of *Onos tricirratus*. In the characters which show distinct changes of growth common to all three species (rising or falling percentages as expressions of the relative proportions of form), this intermediate position should thus be explained as the expression of a more advanced development at a smaller size in the case of *On. fuscus*. But in some respects the intermediate position does not hold good, and *On. fuscus* ranks beside the younger specimens of *On. tricirratus*, or takes a lower place in the scale of development than they. This is the case for example in the relation between the breadth of the interorbital space and the least depth of the tail, a relation which, though it does not afford any constant characteristic difference, still shows distinct changes of growth. In other relations again, as for example in the least depth of the tail expressed in proportion to the distance between the second dorsal fin and the tip of the snout, where we have a constant distinction between *On. tricirratus* and the other two species, *On. fuscus* stands nearer *On. mediterraneus*. Finally, in other relations, in which the direction of development is different in *On. mediterraneus* and *On. tricirratus*, *On. fuscus*, like the early stages of these two species, points still more distinctly to the original starting-point common to the development of the other two species. As an example of this we may take the relation between the postorbital length of the head and the distance between the second dorsal fin and the tip of the snout. This length, expressed in percent of the said distance, relatively decreases with increasing age in *On. mediterraneus*, but increases in *On. tricirratus*, according to the following results of our measurements:

Specimens from	Length of the body expressed in millimetres	Least breadth of the interorbital space in % of the least depth of the tail.			Least depth of the tail in % of the distance between the second dorsal fin and the tip of the snout.			Postorbital length of the head in % of the distance between the second dorsal fin and the tip of the snout		
		Onos mediterraneus.	*Onos fuscus.*	*Onos tricirratus.*	*Onos mediterraneus*	*Onos fuscus*	*Onos tricirratus.*	*Onos mediterraneus*	*Onos fuscus.*	*Onos tricirratus.*
Island-belt of Gothenburg, through A. STUXBERG	430	—	—	65.6		—	23.9	—	—	42.1
Bergen, through the Museum of Upsala University, ♂	360	—	—	70.0		—	22.7	—	—	41.8
Nice, through T. THORELL, specimen in possession of the Museum of Upsala University	293	—	—	77.7			19.1	—	—	41.5
Locality unknown, from the PAYKULL Collection in the Royal Museum	246	60.0	—		15.6		—	34.9		—
Algiers, the property of the Museum of Upsala University	232	64.0	—	—	16.2	—	—	36.3	—	—
Mediterranean, LINNÆUS's type-specimen, from Drottningholm Museum	189	66.0	—		14.7	—	—	37.7	—	—
Naples, through the Zoological Station, ♂	176	—	76.1	—		17.3	—		40.2	—
Nice, through T. THORELL	171	—		76.2	—	—	19.1	—		41.4
Naples, through the Zoological Station, ♀	164	—	81.2	—	—	15.5	—	—	39.4	—
Nice, through T. THORELL	160	—	—	71.4	—	—	20.0	—	—	39.4

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[a] It is a known fact, however, that young Three-bearded Rocklings at the termination of the *Couchia*-period are of a plain reddish brown colour, darker or lighter, and do not show any traces of spots until they have attained a more advanced age.

To judge by these materials, *Onos fuscus* must, therefore, be regarded as the type of the lowest stage of development among the Three-Bearded Rocklings, from which stage each of the other species has adopted a distinct direction; and the intermediate position mentioned above finds a natural explanation in the community of characters that must be more and more pronounced, the nearer the forms which have the same origin, approach to the common original form. As this development of form helps us considerably to a correct understanding of the characters incident to our Three-Bearded Rockling, we here give, instead of a more lengthy description, the following table of measurements:

	Onos fuscus.		*Onos mediterraneus.*				*Onos tricirratus.*	
	Naples, ♀.	Naples, ♂.	LINNÆUS's type-specimen	Algiers.	Locality unknown, from the PAYKULL Collection.	Average in 3 specimens from Nice.	Bergen, ♂.	Island-belt of Gothenburg.
ength of the body expressed in millimetres	164	176	189	232	246	208	360	430
ength of the head in % of the length of the body	20.1	18.7	18.5	19.0	19.5	20.9	20.8	22.5
ongitudinal diameter of the eyes „ „ „ „ „ „ „ „	3.0	2.8	2.7	2.1	3.0	2.8	2.5	2.3
east breadth of the interorbital space „ „ „ „ „ „ „ „	4.0	4.9	3.2	3.4	3.1	4.6	4.7	5.1
ength of the upper jaw „ „ „ „ „ „ „ „	10.4	9.8	9.2	9.5	9.7	11.2	11.1	13.0
„ „ „ lower „ „ „ „ „ „ „ „ „	11.3	10.2	10.6	10.8	11.0	12.2	11.9	13.2
ostorbital length of the head „ „ „ „ „ „ „ „	12.4	12.1	12.2	12.0	11.8	12.9	12.8	13.7
istance between the first dorsal fin and the tip of the snout „ „ „ „ „ „ „ „	17.9	17.5	17.0	17.6	18.3	19.7	20.3	21.1
„ „ „ second „ „ „ „ „ „ „ „ „ „ „ „ „ „ „ „	31.4	30.1	32.3	33.2	33.7	31.6	30.6	32.5
ase of the first dorsal fin „ „ „ „ „ „ „ „	12.1	12.2	13.2	13.1	14.0	11.3	10.0	10.5
„ „ „ second „ „ „ „ „ „ „ „ „ „	52.4	55.7	55.0	55.2	52.4	56.4	55.8	55.1
ength of the first ray of the first dorsal fin „ „ „ „ „ „ „ „	4.9	5.7	5.3	4.7	4.9	3.6	2.1	2.8
„ „ „ longest „ „ „ second „ „ „ „ „ „ „ „ „	9.1	8.5	9.0	7.3	8.3	8.0	8.0	—
„ „ „ pectoral fins „ „ „ „ „ „ „ „	10.6	11.9	11.1	11.0	10.8	12.6	11.9	14.9
„ „ „ ventral „ „ „ „ „ „ „ „ „	11.6	13.6	14.5	12.9	13.3	18.3	13.3	15.3
istance between the ventral fins and the beginning of the anal fin „ „ „ „ „ „ „ „	30.5	25.6	29.6	30.0	30.5	30.3	26.7	26.7
„ „ „ anal fin „ „ tip of the snout „ „ „ „ „ „ „ „	46.3	42.0	44.4	44.4	45.9	46.5	44.2	44.2
ase of the anal fin „ „ „ „ „ „ „ „	38.1	42.6	42.3	39.2	41.0	40.1	43.5	40.7
ongest ray of the anal fin „ „ „ „ „ „ „ „	6.6	6.8	8.4	—	7.0	6.6	6.4	-
east depth of the tail „ „ „ „ „ „ „ „	4.9	5.2	4.7	5.2	5.4	6.1	6.9	7.8
ength of the middle rays of the caudal fin „ „ „ „ „ „ „ „	10.4	10.2	10.6	9.9	9.8	10.7	10.1	10.5
epth of the body at the beginning of the anal fin „ „ „ „ „ „ „ „	12.8	14.5	13.2	12.5	14.4	12.5	14.0	16.3
reatest breadth of the head „ „ „ „ „ „ „ „	11.6	11.4	9.5	10.8	9.7	10.9	12.2	—
umber of rays in the pectoral fins	15	14	15	15	16	20	21	19
„ „ „ „ „ ventral „	6	6	6	7	6	7	7	7

The Three-Bearded Rockling is the largest Scandinavian species of this genus, and attains a length of about half-a-metre. Like the preceding species, it is also one of the most typical species of the genus, with low and broad snout, the tip of which is naked, as the scales of the head do not extend further forward than to the line between the anterior nostrils. The posterior nostrils are set nearer to the anterior ones than to the eyes — sometimes rather near the former — and are without any dermal flap, or have the margin evenly raised into a short tube. The cards of teeth in the jaws and on the head of the vomer are broad and complete. In young specimens the jaw-teeth are of uniform size, but in older ones fairly large canines appear, especially in front in the outermost row of the intermaxillary teeth, and at the middle of the innermost row in the lower jaw. The card of teeth on the head of the vomer forms a more or less acute angle, the sides of which run parallel to the intermaxillary bones, and occupies a space in the palate the breadth of which is greater than the longitudinal diameter of the eyes. The lower margin of the preorbital bones is without barbels, but, especially in old specimens, we often find this margin undulating in a manner that reminds us of the most rudimentary lateral barbels in the preceding species. The lateral line runs in a horizontal direction rather near the dorsal margin back to the 9th or 10th pore, below the anterior part of the second dorsal fin, at which point it descends, reaching the middle of the sides at about the 14th pore, and then running straight back, but disappearing on the hind part of the tail. Altogether we find 26 or 27 distinct pores in the lateral line on each side of the body. Among the internal organs the air-bladder is wanting. The pylorus is furnished with 12—16 cæcal appendages. The peritoneum is black, but the inside of the mouth and the walls of the branchial cavity are white.

The coloration is of a more or less light reddish brown (chestnut-colour) or even grayish yellow, darkest on the back and fading down the sides into the red, yellow, or sometimes white colour of the belly. The head, the sides of the body, the caudal fin, and the pectoral fins are marked with irregularly scattered, roundish spots of darker brown or even of black, and at the top of the back we find a row of numerous, dark, selliform transverse spots, which extend out over the dorsal fin. The upper (outer) part of this fin may also be marked with a row of roundish spots of the same dark colour. The rest of the fins are of a more or less deep red or orange, at least at the margin. The whole of this marking of spots is generally wanting, however, in young Rocklings, which are of a plain reddish brown or marked with lighter (yellow) spots, the belly being lighter, sometimes white.

The fry of the Three-Bearded Rockling (*Couchia argenteola*) resemble the other *Couchiæ*, but are distinguished from them by the number of the barbels. The Swedish Eugenie Expedition found these fry in the Atlantic north of Madeira, and Captain WERNGREN brought home specimens from the Mediterranean. All these specimens, between 27 and 33 mm. long, have only 16—18 rays in the pectoral fins, and thus, according to LÜTKEN's remarks, should be assigned either to *Onos fuscus* or to *Onos mediterraneus*, provided that the number of rays in the pectoral fins be constant even in the fry. The very earliest stages, before the first dorsal fin is distinctly developed, but still some time after the appearance of the nasal barbels, are distinguished, according to LÜTKEN, by two short, erect spines on each temple, a characteristic which led KROYER to label the specimens in Copenhagen Museum with the name of *Motella quadricornis*. In specimens 27 mm. long, however, these spines have already disappeared.

The Three-Bearded Rockling was added to the Scandinavian fauna in 1832 by Professor S. NILSSON, who found it within the island-belt in the neighbourhood of Bergen; and in this district, according to Professor COLLETT, it now and then appears during summer in the market. In 1867 Dr. P. OLSSON saw it taken off Aalesund; but even on the coast of Norway it must be regarded as fairly rare. On the coast of Sweden there is only one recorded instance of its occurrence[a]. On the 22nd of November, 1886, Dr. STUXBERG received a specimen that had been caught in the island-belt of Gothenburg. The species has its true home on the coasts of England and South-western Europe and in the Mediterranean. It generally lives in shallow water, even between the tide-marks, where the bottom is rocky and thickly overgrown with seaweed. Here "it threads its way with great ease and rapidity" (BUCKLAND), or hides itself among the seaweed or under stones. It is also found, however, on a weedy bottom of ooze and in from 30 to 40 fathoms of water. Its food is composed of crustaceans, small fishes, Annelids, and mollusks. It takes a hook readily; and in some parts of England, according to COUCH, it is regarded as a delicacy; but it is generally eaten, says DAY, only by the poor[b], as it acquires a far from pleasant smell soon after death. Its spawning-season seems to occur during winter and in spring. In October THOMPSON met with a male with well-developed testes, while COUCH found the species ready to spawn at the end of April.

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[a] A statement that the species had once before been acquired by Gothenburg Museum, is due, according to Dr. STUXBERG, to some mistake.

[b] This is also the case in Italy, according to NINNI (*Esp. intern. di Pesca*, Berl. 1880, Sez. Ital., Catal., p. 180).

THE FIVE-BEARDED ROCKLING (SW. FEMTÖMMADE SKÄRLÅNGAN OR PERMUCKEN).

ONOS MUSTELA.

Fig. 132 and Plate XXVII. figs. 2 and 3.

Five barbels: one at each of the anterior nostrils, a pair at the tip of the snout, and one under the chin. Length of the head in adult specimens 19—$16^{1}/_{2}$ % of that of the body[a]*. Longitudinal diameter of the eye in full-grown specimens less than 30 % of the postorbital length of the head, this length being greater than either the distance between the tip of the snout and the hind extremity of the maxillary bones or the length of the lower jaw, which is less than half that of the head. Least depth of the tail more than 40 but less than 46 % of the depth of the body at the beginning of the anal fin.*

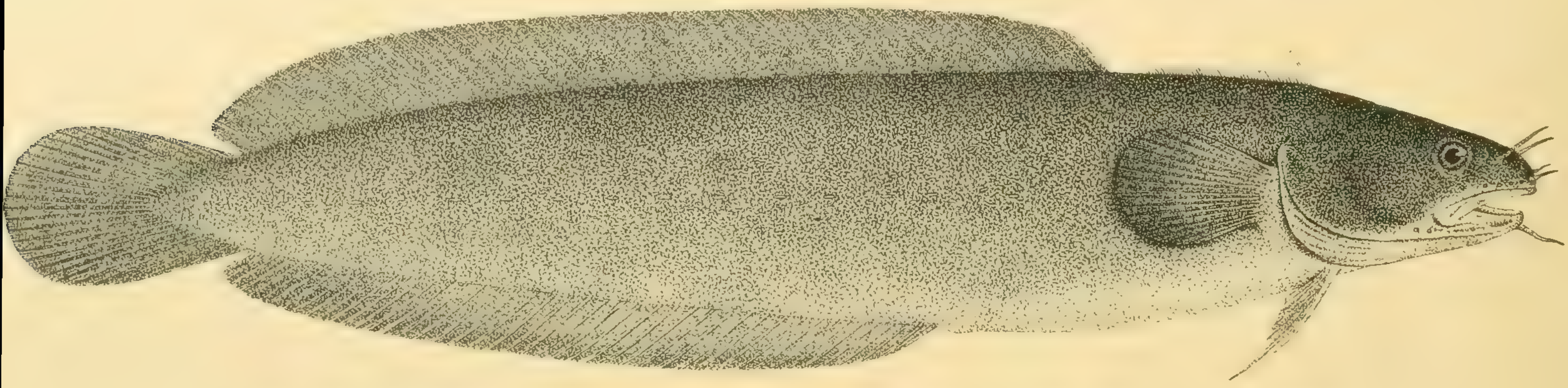

Fig. 132. *Onos mustela*, ♂; natural size; from Strömstad Fjord, 12th Nov., 1882. C. A. Hansson.

R. br. 6—7; *D.* 45—50[b]; *A.* 40—43[c]; *P.* 15—16[d]; *V.* 7—8; *C.* 28—32; *Vert.* 47—48.

Syn. *Gadus mustelaris*, Lin., *Mus. Ad. Frid.*, I, p. 75.

Gadus Mustela, Lin., *Syst. Nat.*, ed. X, tom. I, p. 255; Penn., *Brit. Zool.* (1776), tom. III, p. 177; Gmel., *Syst. Nat. Lin.*, tom. I, pt. III, p. 1173; Hollberg, Gbgs Wett., Witt. Samh. N. Handl., vol. IV (1821), p. 52; Faber, *Fish. Isl.*, p. 81; Nilss. (*Motella*), *Prodr. Ichthyol. Scand.*, p. 49; Schagerstr., Physiogr. Sällsk. Tidskr., p. 305; Kr., *Danm. Fisk.*, vol. II, p. 185 (add. vol. I, p. 609); Ekstr., Gbgs Vet., Vitt. Samh. Handl., N. Tidsf., H. I (1850), p. 39; Nilss., *Skand. Fn.*, *Fisk.*, p. 589; Gthr, *Cat. Brit. Mus.*, *Fish.*, vol. IV, p. 364; Coll., Forh. Vid. Selsk. Christ. 1874, Tillægsh., p. 117; Malm, *Gbgs, Boh. Fn.*, p. 495; Winth., Naturh. Tidskr. Kbhvn, ser. 3, vol. XII, p. 33; Mor., *Hist. Nat. Poiss. Fr.*, tom. III, p. 273; Ltkn, Vid. Meddel. Naturh. For. Kbhvn, 1881, p. 234; Day, *Fish. Gt. Brit.*, *Irel.*, vol. I, p. 314, tab. LXXXVIII, fig. 2; Coll. (*Onos*), N. Mag. Naturv. Christ., Bd. 29 (1884), p. 85; Lillj., *Sv.*, *Norg. Fisk.*, vol. II, p. 185; Hansen, *Zool. Dan.*, *Fiske*, p. 84, tab. X, fig. 4.

Gadus quinquecirrhatus, Cuv. (ex Penn.) *R. Anim.*, ed. I, tom. II, p. 216; Yarr. (*Motella*), *Brit. Fish.*, ed. I, vol. II, p. 190; *Parn.*, Mem. Wern. Nat. Hist. Soc., vol. VII, p. 355.

Ciliata glauca, Couch, Loud. Mag. Nat. Hist., vol. V, pp. 15 et 741; Jenyns (*Motella*), *Man. Brit. Vert. Anim.*, p. 451; Thomps. (*Couchia*), *Nat. Hist. Irel.*, vol. IV, p. 188 (+*Couchia minor*); Coll. (*Motella*), Forh. Vid. Selsk. Christ. 1874, Tillægsh., p. 121.

Motella argenteola, v. Düb., Kor. (nec Montagu) Vet.-Akad. Handl. 1844, p. 92; Nilss., *Skand. Fn.*, *Fisk.*, p. 590.

According to Pennant and Fleming[e], it is true, the Five-Bearded Rockling attains a length of about $4^{1}/_{2}$ dm. (18 in.); but specimens of this size are otherwise unknown. The largest specimens in the Royal Museum are $2^{1}/_{2}$ dm. long, and Malm never found the length of this species to exceed 28 cm. on the coast of Bohuslän.

The head is comparatively small, with small eyes and flat but comparatively broad interorbital space. The tip of the snout is naked for a greater distance than in the Three-Bearded Rockling, the boundary of the scales running between the posterior nostrils or even in a line with the front part of the eyes. The posterior nostrils are set nearer to the eyes or at least half-way between the latter and the nasal barbels, and their anterior margin is usually raised into a semicircular dermal flap. The mouth is comparatively small, and the teeth are blunter than in the preceding species and of more uniform size, the inner row in the lower jaw being generally the only one distinguished by somewhat larger teeth. The breadth in the palate of the vomerine card of teeth is always less than the longitudinal diameter of the eyes. The two rostral barbels, which this species possesses in common with the Northern Rockling, are well separated from each other, but the distance between them is less than their length. At the lower margin of the snout (the lower preorbital margin), on each side of these barbels, we find here, as in many specimens of the preceding species, sinuous contractions, the spaces between which remind us of the rudimentary barbels in the Northern Rockling. The scales are small but dense, and extend, as in the preceding forms, out over the pectoral fins and the vertical fins, especially the caudal. The light-coloured pores of the lateral line are in most cases rather indistinct, as in the rest of the genus, and the lateral line often seems to be interrupted in its curved part, below the anterior part of the second dorsal fin. Where we have found this line most nearly perfect, it has contained 22 pores, arranged thus:

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[a] In young specimens, even after the *Couchia*-stage, this proportion may be $22^{1}/_{2}$ %.

[b] Sometimes 55, according to Day.

[c] ,, 46, ,, ,, ,,

[d] ,, 14, ,, ,, Moreau.

,, 17, ,, ,, Kroyer.

,, 18, ,, ,, Faber.

[e] *Brit. Anim.*, p. 193.

1st — 7th
8th
9th —22nd

The relation between this species and the preceding ones is shown most clearly, however, in the following table of measurements:

Onos mustela.		A young specimen from Bohuslän, Dec., 1836.	Average in 5 specimens from Bohuslän, between 111 and 248 mm. long.
Length of the body expressed in millimetres		80	191
Length of the head	in % of the length of the body	22.5	17.8
Longitudinal diameter of the eyes	„ „ „ „ „ „ „ „	2.9	2.5
Least breadth of the interorbital space	„ „ „ „ „ „ „ „	4.3	5.0
Length of the upper jaw	„ „ „ „ „ „ „ „	11.3	7.4
„ „ „ lower	„ „ „ „ „ „ „ „	9.3	8.2
Postorbital length of the head	„ „ „ „ „ „ „ „	13.8	11.1
Distance between the first dorsal fin and the tip of the snout	„ „ „ „ „ „ „ „	20.4	16.7
„ „ „ second „ „ „ „ „ „ „ „	„ „ „ „ „ „ „ „	32.0	30.4
Base of the first dorsal fin	„ „ „ „ „ „ „ „	9.5	11.1
„ „ „ second „ „	„ „ „ „ „ „ „ „	52.8	54.8
Length of the first ray of the first dorsal fin	„ „ „ „ „ „ „ „	5.0	4.8
„ „ „ longest „ „ „ second „ „	„ „ „ „ „ „ „ „	—	7.4
„ „ „ pectoral fins	„ „ „ „ „ „ „ „	12.4	11.6
„ „ „ ventral „	„ „ „ „ „ „ „ „	13.7	11.0
Distance between the ventral fins and the beginning of the anal fin	„ „ „ „ „ „ „ „	24.5	27.4
„ „ „ anal fin „ „ tip of the snout	„ „ „ „ „ „ „ „	41.5	41.1
Base of the anal fin	„ „ „ „ „ „ „ „	40.8	43.8
Longest ray of the anal fin	„ „ „ „ „ „ „ „	8.2	6.6
Least depth of the tail	„ „ „ „ „ „ „ „	5.4	6.6
Length of the middle rays of the caudal fin	„ „ „ „ „ „ „ „	10.0	10.0
Depth of the body at the beginning of the anal fin	„ „ „ „ „ „ „ „	12.6	14.7
Greatest breadth of the head	„ „ „ „ „ „ „ „	11.3	10.4

Thus, in the Five-Bearded Rockling the length of the lower jaw and (as a rule) of the upper is less than half that of the head; and in all the older specimens (more than 1 dm. long) the former is less than 9 %, the latter less than 8 %, of the length of the body. In these respects the Five-Bearded Rockling differs from all the other Scandinavian species of the genus. In the young specimen, however, the length of the lower jaw in proportion to that of the body falls within the limits of individual variation in the Four-Bearded Rockling; and the length of the upper jaw (from the tip of the snout to the hind extremity of the maxillary bones) corresponds in this relation to the averages both in the three-bearded and the four-bearded species. In all the older specimens the base of the anal fin is greater than the distance between this fin and the tip of the snout. This is also the case in the Four-bearded Rockling; but in the young specimen of the Five-bearded Rockling, as well as in the Three-bearded and the Northern Rocklings, the base of this fin is less than the said distance. The almost uniform size of the jaw-teeth in the Five-bearded Rockling is a persistent juvenile character, which this species possesses in common with young specimens of the Three-bearded Rockling; but the card of teeth on the head of the vomer is never so broad in the former as in the latter, although it does not undergo so great reduction as in the Four-bearded Rockling.

The Five-Bearded Rockling thus ranks as an intermediate form between the preceding ones, as we have above found to be the case with *Onos fuscus* in its relations to *On. mediterraneus* and *On. tricirratus*. That the original form of the whole genus was three-bearded seems highly probable, as the difference between the unpaired and the paired arrangements of the rostral barbels, presupposes a stage of development in which this difference did not exist. In other respects, however, *Onos mustela* forms a connecting link between the two directions of development, and may, therefore, in all probability be regarded, to the best of our knowledge, of the genus in its present arrangement, or at least of the North Atlantic and the Mediterranean species, as the least differentiated (most nearly original) type within the genus.

In the Five-Bearded Rockling the coloration is of a more or less dark reddish brown or even olive-green on the dorsal side, light grayish, white, yellowish, or sometimes reddish on the belly, without any sharp line of demarcation and without true spots. Sometimes, however, we find indistinct, clouded spots on the sides, caused by the denser agglomeration of the fine, dark brown dots that are scattered over the whole body. The sides of the body show a metallic — or silvery — lustre. The second dorsal fin at the base is of the same colour as the back, the anal fin as the belly, but the outer and especially the posterior parts of these fins are blackish. The pectoral fins are also blackish, but of a more or less distinct orange at the base. At the extreme margin all these fins are usually edged with red. The nasal and rostral barbels are of the same colour as the dorsal side or still darker, the barbel under the chin of the same colour as the belly. During life the ventral fins are reddish (HOLLBERG), or have "orange rays, with whitish-yellow membrane" (SCHAGERSTRÖM). The "small black dots which are set in oblique rows across the sides" (HOLLBERG), are the pigmented dermal coverings of the several scales, an ordinary characteristic of the whole of this genus, which statement also applies to the fine, dark brown dots that are scattered over the body. In a live young specimen 78 mm. long COLLETT found the pupil to be of a handsome emerald-green, and the iris red, with a metallic lustre.

In the fry (*Couchia glauca* — Plate XXVII, fig. 3), which have been most fully described, under the name of *Motella argenteola*, by v. DÜBEN and KOREN, the back is bluish green down to a level with the upper corners of the gill-openings, and forms a sharp contrast to the white, silvery lustre of the sides. All the fins are transparent and white, except the ventrals (fig. 134), the black tip of which grows more and more indistinct, however, as the fins are shortened during growth, and their insertion removed further and further forward, until in specimens about 25 mm. long these fins are also pure white. The development is subject to extreme variations; but the scales do not appear until the fish is about 38 mm. long, while the strong, silvery lustre is still persistent, until the fish has attained a length of 40—45 mm., and even then, as we have remarked above, does not disappear entirely. On the other hand, the dermal carina that runs on each side of the back from the end of the first dorsal fin along the base of the second dorsal, as well as the similar carina on each

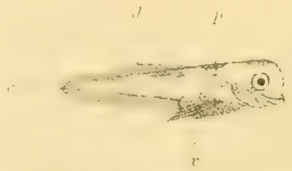

Fig. 133. Young *Onos*. 6 mm. long, with projecting lower jaw. After M'INTOSH and PRINCE. *p*. pectoral fin; *v*. ventral fin; *d* and *c*, the still confluent dorsal and ano-caudal fins.

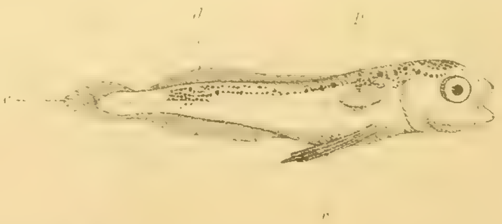

Fig. 134. Young *Onos*. 10 mm. long, with black tip to the ventral fins. After M'INTOSH and PRINCE. *p*. pectoral fin; *v*. ventral fin; *d*. dorsal fin; *c*. caudal fin.

side of the base of the anal fin, is an evanescent formation. In full-grown specimens we now and then find these carinæ replaced by longitudinal grooves. They seem to be most nearly represented in the family *Ammodytidæ*, of which fishes we are also strongly reminded by the coloration and the silvery white, naked skin. The truncate or even somewhat, though only slightly, concave caudal fin, contrasted with its sharply rounded form in adult specimens, also reminds us of the Ammodytoids. Even in young specimens 41 mm. in length, however, we may find the coloration of the adult specimens almost perfectly represented, though a steel-blue longitudinal band is still present as a trace of the original boundary between the colours of the back and of the sides. A specimen of this kind, which is preserved in the Royal Museum, was taken, together with a number of others between 25 and 42 mm. long, all in *Couchia*-dress, by Fisherman TOBIAS ANDERSSON, on the fishing-bank N.W. of Bergen, where the depth of water was about 150 fathoms. In this specimen the length of the head is 20·5 %, the longitudinal diameter of the eyes 4·6 %, the breadth of the interorbital space 5·1 %, the length of the upper jaw 9·7 %, of the lower jaw 10 %, the postorbital length of the head 11·9 %, the depth of the body at the beginning of the anal fin 14·6 %, and the least depth of the tail 4·9 %, of the length of the body. The specimen can hardly be referred, therefore, to *Onos septentrionalis*, though three tubercular swellings appear at the lower preorbital margin on each side of the slightly more developed rostral barbels. Among the barbels the rostral ones are developed last, though the length of the body at this period varies considerably, but generally measures about 21 mm., at which time the breadth of the interorbital space may already be greater than the longitudinal diameter of the eyes, though as a rule it is less. Not until the rostral barbels are developed, though they may still have the form of small, terete protuberances, can we distinguish this species with certainty from the preceding one.

The internal organs of the Five-Bearded Rockling resemble those of the preceding forms in all essential respects; but the few (8—10) pyloric appendages are still longer, and their tips lie rather near the vent. The air-bladder is wanting. The peritoneum, the inside of the mouth, and the walls of the pharynx are white.

Onos mustela is an East Atlantic species, with range extending from the extreme north of Norway — where it has been found, according to COLLETT, in Ox Fjord — and from Iceland (FABER) southwards at least to the north-west of Spain (STEINDACHNER) and Portugal (LOWE, in the British Museum). Great Britain thus seems to be the centre of its range; and to all appearances it is on the British coasts that the Five-Bearded Rockling is commonest. The secluded haunts frequented by the adult specimens render this species, like the other species of the genus, hard to find, except when it is left behind in pools, under stones etc., by the ebb-tide, and it is caught only by accident when the fisherman is engaged in fishing for other species. It is, therefore, difficult to decide how rare or common the species is: but, while English naturalists state that it is common on the British coast, the information on this point from Scandinavia is less definite. Even in STRÖM's time the species was known off Söndmör[a], but COLLETT does not regard it as plentiful on the coast of Norway, though he points out that the large numbers in which the fry sometimes appear at the surface, seem to show the contrary. In Bohuslän the species has received a special name (*Permuck*), and is, therefore, well-known to the fishermen — EKSTRÖM, NILSSON, and MALM state that it is common there — but HOLLBERG described it as rather rare, and in recent times the Royal Museum has had very great difficulty in procuring specimens thence. According to KRØYER it is also "extremely rare" in the north of the Cattegat. SCHAGERSTRÖM found it rare in the Sound. In the Baltic it has never been met with.

In its adult state the Five-Bearded Rockling seems to prefer a rocky bottom, but is also found on sandy ground, when this is firm and studded with tufts of seaweed. It belongs to the littoral fishes, and, so far as is known, does not descend into deep water, beyond the limits to which the green algæ extend. Thus it is often met with between the tide-marks; and on the coast of Iceland, after the storms of winter, FABER saw hundreds of specimens that had been cast ashore by the waves to furnish a dainty meal to the ravens and seagulls. MALM assumes that on the coast of Bohuslän this species is commonest at a depth of 8—12 fathoms; while the Royal Museum possesses several specimens taken at less depths, but one from a depth of 20—30 fathoms in Gullmaren. It feeds on small fishes, mollusks, and crustaceans; one of the Royal Museum specimens has its stomach distended by a shrimp that it has swallowed. The spawning-season proper seems to occur in winter and spring, though it may begin as early as August, for at the end of this month Cornish found a gravid female with partially ripe eggs. According to Couch[a] the Five-Bearded Rockling builds a kind of nest with the common coralline (*Corallina officinalis*) for its eggs. The eggs and the sprigs of seaweed are packed one after another in a hole or rocky crevice at low-water mark. Brook[b] has already remarked, however, that this account of the laying of the eggs may be due to a confusion with some other species, for he found the eggs floating about in the water of his aquarium, where he had some females of this species which spawned in May and June. M'Intosh and Prince[c], on the other hand, found the eggs floating in the sea between March and May, and in their aquarium the females spawned in April. It is at the middle of May too, according to Couch, that the fry first appear at the surface, staying there until the end of autumn. During this season they live in the same manner as the other *Couchiæ*, being lively and, for their size, voracious, but cautious and always ready to take shelter under any floating object, often among the tentacles under the disk of a jelly-fish. Birds and fishes chase them eagerly, and as food for larger fishes they are not without importance. The full-grown Rocklings also contribute to the support of the large bottom-fishes; but on account of its small size, in Scandinavia at least, the Five-Bearded Rockling is of little importance as human food. Parnell tells us, however, that at midsummer it is pretty often taken on the hook in the Firth of Forth and brought to Edinburgh for sale, being exposed in the market with Codlings and Whiting, and forming a very palatable dish when fried.

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[a] *Beskr. Söndm.*, pt. I, p. 314: *Det andet Slags Tang-Brosme*.

Genus RANICEPS.

Two dorsal fins, the anterior being, however, rudimentary and hardly distinguishable, with only three rays: one anal fin. Ventral fins with 6 rays, the first two ending in long, free, curved tips. Cardiform teeth on the intermaxillary bones, in the lower jaw, and on the head of the vomer. Branchiostegal rays 7.

This genus contains only one species, which is further distinguished by a large, broad, depressed head, brachiate pectoral fins (with long base, set, as it were, on a short shaft), a short barbel under the chin, and the absence of cæcal appendages (though we find rudimentary traces thereof) round the pylorus. It also differs, though with individual variations, from the other genera of the Gadoid family in the ciliation of the scales at the margin.

The name of *Raniceps* was given the genus by Cuvier (1817). Two years after, in 1819, Hollberg bestowed upon it a name of Greek derivation (*Batracocephalus*), but of the same meaning (Frog's-head).

THE LESSER FORKED BEARD OR TADPOLE FISH (SW. MATFAREN OR PADDTORSKEN).

RANICEPS RANINUS.

Plate XXV, fig. 3.

Coloration brownish black, with white edges to the second dorsal fin, at the top of the caudal fin, and in front of the anal fin; the free tips of the ventral rays also white. Walls of the mouth and of the pharyngeal cavity white.

R. br. 7; *D.* 3 61—67; *A.* 55—61; *P.* 21—23; *V.* 6; *C.* 31—35; *Vert.* 44—45.

Syn. *Lesser forked-beard* (*Barbus minor Cornubiensis*), Jago apud Raium, *Syn. Meth. Pisc.*, p. 164, fig. 8; *Blennius fuscus*,

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[a] *Fish. Brit. Isl.*, vol. III, p. 109.

[b] Journ. Lin. Soc. London, Zool., vol. XVIII (1885), p. 298.

[c] Trans. Roy. Soc. Edinb., vol. XXXV, part. III, p. 832.

ore cirrato, pinnis omnibus setaceis, Strøm, *Søndm. Beskr.*, part. I, p. 323; *Trifurcated Hake*, Penn., *Brit. Zool.* (1776), tom. III, p. 172, tab. XXXII.

Blennius raninus, Lin. (p. p.), *Syst. Nat.*, ed. X, tom. I, p. 258; *Fn. Suec.*, ed. II, p. 113; Müll., *Zool. Dan. Prodr.*, p. 43; Brünn (*Gadus*), Vid. Selsk. Skr. Kbhvn. part. XII (1777), p. 291 (cum 2 tab.); Müll., *Zool. Dan.*, vol. II (1788), p. 6, tab. XLV; Cuv. (*Raniceps*), *Régn. Anim.*, ed. I, tom. II, p. 217; Coll., Forh. Vid. Selsk. Christ., 1874, Tillægsh., p. 125; Malm, *Gbgs*, *Boh. Fn.*, p. 498; Winth., Naturh. Tidskr. Kbhvn, ser. 3, vol. XII, p. 34; Day, *Fish. Gt. Brit.*, *Irel.*, vol. I, p. 320, tab. XC, fig. 1; Möb., Heke, *Fisch. Osts.*, p. 84; Lillj., *Sv.*, *Norg. Fisk.*, vol. II, p. 195; Hansen, *Zool. Dan.*, *Fiske*, p. 87, tab. X, fig. 6.

Blennius fuscus, Müll., *Zool. Dan. Prodr.*, p. 43 (ex Ström); Kr. (*Raniceps*), *Danm. Fiske*, vol. II, p. 231.

Gadus fuliginosus, Walb., Schr. Ges. Nat Fr. Berl., vol. V (1784), p. 107.

Gadus raninus, var. *α*, *trifurcus*, Walb., *Ichthyol. Art.*, part. III, p. 139 (ex Penn.); *Blennius trifurcatus*, Shaw., *Gen. Zool.*, vol. IV, part. I, p. 174 (ex Penn.); Gthr (*Raniceps*), *Cat. Brit. Mus.*, *Fish.*, vol. IV, p. 367; Mor., *Hist. Nat. Poiss. Fr.*, tom. III, p. 275.

Gadus minimus, Walb., *Ichthyol. Art.*, part. III, p. 143 (ex Jagone).

Batracocephalus blennioides, Hollb., Gbgs. Wett., Witt. Samh. n. Handl., part. III (1819), p. 39 cum tab.

Raniceps niger, Nilss., *Prodr. Ichthyol. Scand.*, p. 50; Schagerstr., Physiogr. Sällsk. Tidskr., p. 310; Fr., Ekstr., *Skand. Fisk.*, ed. I, p. 92, tab. 21; Nilss., *Skand. Fn.*, *Fisk.*, p. 594.

Obs. Linnæus's diagnosis evidently refers to this species; but by some mistake or other he stated that the fish was a fresh-water species that lived in the lakes of southern Sweden, and was there known by names which show that he confused it with the Burbot. Ström suspected and Brünnich corrected this mistake.

The Tadpole Fish (Sw. *Paddtorsk* = Toad Cod) does not attain any considerable size, being generally between 20 and 25 cm., and at most 30 cm. long. When seen from above the body is of a marked wedge-shape, tapering in the hind part, which thus forms a sharp contrast to the roundish, broad, depressed head. The body is deepest across the belly at the beginning of the second dorsal fin, from which point it tapers more rapidly, though only gradually, towards the tail, and more imperceptibly towards the head. However, as the width of the belly depends, as usual, to a great extent on the quantity of food it contains, or the tumidity of the organs of generation, it is usually safer to measure the depth of the body at the beginning of the anal fin, though this is not the deepest point. We have found the latter depth to measure in young specimens (between 6 and $6^1/_2$ cm. long) about 14 % of the length of the body, and in older specimens (between $11^1/_2$ and $28^1/_3$ cm. long) about 18—21 % of this length. The depth of the tail at the ends of the second dorsal and the anal fins — where scarcely any finless space is to be found in most specimens — measures about 4—$4^1/_2$ % of the length of the body, and is always less than the longitudinal diameter of the eyes. During the life-time of the fish the back and the top of the head form a slight and regular convexity, overtopped by the eyes, which are rather prominent.

The head is broader than the body, its greatest breadth in young specimens being about $^2/_3$, in old ones about $^4/_5$ of its own length, which in the former measures about 26 or 27 %, in the latter 28—30 % of the total length of the body, or respectively 29—31 % and 32—33 % of the length of the body excluding the caudal fin. The eyes are fairly round, their length being only slightly greater than their depth, and their longitudinal diameter measuring $^1/_5$—$^1/_6$ of the length of the head. They are turned upwards and set far apart, their longitudinal diameter being only from $^1/_2$ to $^2/_3$ of the least distance between them, which measures between about 9 and 10 % of the length of the body or $^1/_3$ of that of the head. They are also set so far forward that the length of the snout varies between about $^2/_5$ and $^1/_2$ of that of the head behind them. The snout is rounded and very broad, and projects some way beyond the margin of the upper jaw. The nostrils are set obliquely in front of the eyes and nearer to them than to the snout; the posterior is simply a round hole, the anterior raised at the margin into a tube open in front, or with a triangular flap at the hind margin. The lower jaw falls short of the upper in front, and is furnished with a very short barbel under the chin. The length of the branches of the lower jaw is about $15^1/_2$—$16^1/_2$ % of that of the body. The gape is large and almost circular. When the mouth is open, the whole of the branchial arches and of the pharyngeals is visible. The upper jaw is then protruded only very slightly, but the corners of the mouth all the more distinctly. When the mouth is closed, both the maxillary bones retire below the labiate dermal fold formed by the lower margin of the snout, and the thick labial skin that forms the corners of the mouth falls into a deep groove above and behind the maxillaries. The length of the upper jaw (from the tip of the snout to the hind extremity of the maxillary bones) increases with age from about 14 to nearly 17 % of that of the body. The tongue is thick, but short, cartilaginous, with truncate, rounded tip, the free part of which is sometimes hardly distinguishable. Both jaws are furnished with pointed, cardiform teeth in dense, irregular rows, the outermost row containing the largest teeth both in the upper jaw and the lower. A similar card of teeth, set across the palate and curved, occupies the head of the vomer. The upper pharyngeals on each side form two disks, crowded with fine, rather blunt teeth. The anterior disk is narrow and of uniform breadth, the posterior (on the two hind pharyngeals, which are coalescent) large and quadrangular with rounded corners or crescent-shaped. The cards of teeth on the lower pharyngeals are oblong. The four branchial arches are furnished with short, spiny protuberances instead of gill-rakers. The gill-openings are large. The branchiostegal membrane is moderately incised underneath, with a narrow, free, dermal margin across the isthmus. The whole head is clothed with a thick, mobile skin, loosely attached to the body, and entirely covering and concealing the opercular bones.

In structure the scales of the Tadpole Fish very closely resemble those of the preceding genus. They are furnished exclusively with concentric, denticulated striæ (ridges). On the other hand, the nucleus is usually very large — though sometimes reduced in the extreme — and only the younger (smaller) scales have continuous striæ, following the elliptical or oblong outlines of the scale. In other cases they are more or less interrupted at both ends of the scale, in the anterior (inserted) part to leave room for a longitudinal, smooth patch at the middle, as a continuation of the nucleus, and in the posterior (free) part of the most developed scales to correspond to the configuration of the truncate margin of the scale. This margin is furnished with a greater or less number of teeth — KROYER has counted as many as 18 — and here the said striæ partly run straight out to the margin, and partly scatter into small, irregular, vermiform, transverse striæ. We must remember, however, that these ciliate teeth at the hind margin of the scales are often wanting: in some specimens we have failed to discover any of these ciliated, truncate scales, while in others they apparently occur only on the hind part of the body. The scales on that part of the body which lies behind the vent, are also more regularly arranged and flat, but on the forepart of the body as well as on the head they are more irregular, rather more depressed, and as it were concave. During life the fish is coated with a thick layer of slime, which entirely conceals the scales, and renders the whole surface of the skin smooth and shiny. The lateral line, which is only slightly marked, and forms a small curve in front, is hardly distinguishable during the life of the fish, but in specimens that have long been preserved in spirits, this curve appears as a row of light-coloured protuberances[a].

The vent is large and thick-lipped, with an anal papilla behind it, and is situated just in front of the beginning of the anal fin.

The pectoral fins are fairly large, their length being about 15[b]—17 % of that of the body, and are rounded at the tip. Their basal part is somewhat elongated (brachiate), and their rays, of which the middle ones are longest, are thick at the base and at the tip very regularly divided into 8 branches, running parallel to each other.

The ventral fins are set farther forward than the pectoral, at a distance from the beginning of the anal fin of about $18^{1}/_{2}$—22 % of the length of the body. They contain 6 rays, the first two being much longer than the others and furnished with long, free, filamentous tips, arched in a forward direction. The second ray is the longest, sometimes measuring as much as $18^{1}/_{2}$ % of the length of the body. The four inner rays are small, closely united, and branched, but with the tips themselves as it were coalescent.

The first dorsal fin, which begins at a distance from the tip of the snout measuring in young specimens 26—28 %, in old 29—33 %, of the length of the body, is only rudimentary. It is set in a deep groove formed by the dorsal edge, and is composed of one large, distinct, simple ray, which is, however, short, its length being always less than the longitudinal diameter of the eye, and behind which we find two extremely small and indistinct rays. The latter rays can often be distinguished only with the help of scalpel and magnifying-glass. The second dorsal fin begins just behind the perpendicular from the base of the pectoral fins, at a distance from the tip of the snout of about 31—36 % of the length of the body. It is of almost uniform height, and runs along the back for a distance equal to about 49—54 % of the length of the body, to the very base of the caudal fin, the space between these fins being extremely small or hardly perceptible.

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[a] "Above the pectoral fins, on each side, was a row of tubercles from which commenced the lateral line, which was (midway) incurvated": PENNANT, l. c.

[b] In our largest specimen 14.

Its depth (the length of the longest rays) is about 9 or 10 % of the length of the body.

The anal fin is of the same form and the same extent in a backward direction as the second dorsal; but the interval between this fin and the caudal fin is sometimes more distinct, though only inconsiderable, and the fin is shorter. The distance between the tip of the snout and the beginning of this fin is 37—38 % of the length of the body in young specimens, 40—43 % in old, and its base usually measures about 45 % of the length of the body.

The caudal fin is comparatively small, with narrow base and expanded, rounded hind margin. In young specimens the length of its middle rays is about 12 %, in older ones 10—$9^1/_2$ %, of the length of the body.

The entire coloration of this fish is very monotonous, of a deep brownish black with a bright and handsome, blue lustre, which throws brilliant lights on the smooth surface of the body. The skin of the mouth and the grooves which receive the upper jaw and the labial skin, are whitish. The iris is yellowish, and the pupil has a blue lustre. The fins are of the general colour of the body, but the free tips of the ventral rays, the extreme margin of the whole of the second dorsal fin, of the beginning of the anal fin, and of the top of the caudal fin are whitish. After the death of the fish, the colours fade and turn reddish, and the lustre disappears. A young specimen 13 mm. long which Malm caught on the 23rd of July, 1875, in Lunnevik (Gåsö, Bohuslän), was entirely whitish, with the exception of the ventral fins, which were deep black, while a blackish brown pigment also appeared on the head, the front part of the sides, and across the occipital region. Still, the typical form of the species was already developed.

In its internal structure the Tadpole Fish essentially resembles the Cods, and the abdominal cavity extends some way, though not very far, behind the beginning of the anal fin. But the character that sharply separates this fish from most of the preceding genera, is that the numerous pyloric appendages of the other genera are here wanting. The Tadpole Fish is furnished merely with two (sometimes only one) short projections or expansions of the intestine, rudimentary traces of these appendages, and occupying the same position. The air-bladder is divided into two parts, the anterior larger and more expanded in a lateral direction than the posterior.

On account of its black colour the Tadpole Fish is known at some spots in the island-belt of Bohuslän as *Smed* (Blacksmith) and *Bläckfisk* (Ink-fish). It is also called *Matfar* (Breadwinner), *Paddål* (Toad Eel), and *Hulekolja* (Cave Haddock). In the Sound, according to Schagerström, it bears the name of *Hafpadda* (Sea Toad).

The geographical range of the Tadpole Fish extends from the neighbourhood of Trondhjem to England, Ireland, and the coasts of the Channel, but on the north-west coast of France, according to Moreau, it is extremely rare. It is no common fish on the English coast either, and seems, therefore, to be really Scandinavian. It occurs both on the Norwegian coast and on the coast of Bohuslän as well as throughout the Cattegat. From the last locality it occasionally enters the Sound and Ise Fjord, and passes through the Belts down to the neighbourhood of Kiel and the coast of Mecklenburg. On the Baltic coast of Scania, however, this species has not been found.

Its habits probably resemble those of the preceding genus, and it is usually found in solitary specimens at rather shallow spots (in 5—12 fathoms of water, according to Malm), among the seaweed at the bottom. Off Kullen, however, according to Nilsson, it sometimes happens, in late autumn, that three or four specimens are taken in one and the same Cod-net. Otherwise it is caught only by accident in every kind of fishing-tackle, such as lobster or crab pots etc., but on the coast of Bohuslän, according to Fries, oftenest on Haddock-lines, when these are set during autumn at shallow, weedy spots for the so-called Grass Cod. That it also descends to greater depths is shown by a large specimen which Mr. C. A. Hansson has forwarded to the Royal Museum, and which was taken at a depth of 40 or 50 fathoms in Strömstad Fjord.

Its food is composed of all kinds of lower marine animals, such as crustaceans, mollusks, worms, and especially Echinoderms (sea-urchins and star-fish), fragments of which have been found in its stomach and intestine. But it is by no means averse to fish, for in two of the specimens we have examined we found the stomach in each case to contain the head of a small Herring.

Nilsson was told at Kullen that the Tadpole Fish spawns between Martinmas and Christmas, but this is probably an exception to the general rule. In the month of July Fries observed on the coast of Bohuslän two Tadpole Fish that kept close to each other, and, caressing each other in everyp ossible manner, came right up to a landing-place in 3 dm. of water, where they finally hid themselves under the frame of the pier. It was at the end of July too, that MALM took the above-mentioned young specimen 13 mm. in length, close to the land and 3 dm. from the surface in 6 dm. of water. In October, 1882, Mr. TRYBOM, Assistant Inspector of Fisheries, received from the fishermen of Råå two young Tadpole Fish between 6 and 6$^1/_2$ cm. long. All these circumstances go to show that the spawning-season occurs in summer or spring.

As the Tadpole Fish is caught only in small numbers and has a slimy and repulsive appearance and an unpleasant odour, it is despised by the fishermen and seldom used as food. Most of the specimens taken are thrown away at once. Still, the flesh is white and firm, and, no doubt, of as good flavour as that of several other Codfishes. (FRIES, SMITT.)

GENUS **BROSMIUS.**

Only one dorsal fin and one anal. Ventral fins with 5 rays of fairly uniform length, the anterior ones with short, free tip. Cardiform teeth on the intermaxillary bones, in the lower jaw, and on the head of the vomer. Branchiostegal rays 7.

This genus also contains only one species, which is of true northern nature, belonging to the Arctic Ocean and the North Atlantic.

The genus stands alone among the Codfishes in its possession of only one dorsal fin; but in other respects it comes near the Lings and the Burbot, and especially to the Rocklings. The single species has long been known and has long passed in the trade in Norway[a] by the name of *Brosme*, in Iceland[b] by that of *Keila*, and in England[c] by those of *Torsk*, *Tusk*, and *Brismak*. For all this it was unknown to ARTEDI and LINNÆUS. CUVIER established[d] a Gadoid subgenus which he called *Les Brosmes;* and FLEMING[e] adopted *Brosmus* as a distinct genus.

THE TORSK OR TUSK (SW. LUBBEN).

BROSMIUS BROSME.

Plate XXV, fig. 4.

Coloration light gray, more or less mixed with yellow, on the belly grayish white; the vertical fins edged with white and with a black band within this margin.

R. br. 7; *D.* 90[f]—105; *A.* 71[g]—76; *P.* 22[h]—24; *V.* 5; *C.* 2 + 42 + 2; *Vert.* 63—66.

Syn. *Gadus brosme*, ASCAN., *Ic. Rer. Nat.*, Fasc. II, p. 7, tab. XVII; FABR., FD. Groenl., p. 149; WALB., *Ichth. Art.*, *Gen. Pisc.*, p. 142; RETZ., *Fn. Suec. Lin.*, p. 323; FABER, *Fisch. Isl.*, p. 84; NILSS., *Prodr. Ichth. Scand.*, p. 47; VAL., *Voy. Isl.*, *Groenl.*, GAIM., Atl., Poiss., tab. 5; EKSTR., Gbgs. Vet., Vitt. Samh. Handl., Ny Tidsf., Häft. I (1850), p. 39; GTHR (*Brosmius*), *Cat. Brit. Mus.*, *Fish.*, vol. IV, p. 369; COLL., Forh. Vid. Selsk. Christ. 1874, Tillægsh., p. 125; ibid. 1879, No. 1, p. 69; MALM, *Gbgs*, *Boh. Fn.*, p. 499; GOODE, BEAN, Proc. U. S. Nat. Mus., vol. I (1878), p. 362; DAY, *Fish. Gt. Brit.*, *Irel.*, vol. I, p. 323, tab. XC, fig. 2; JORD., GILB., Bull. U. S. Nat. Mus., No. 16, p. 802; STORM, Vid. Selsk. Skr. Throndhj. 1883, p. 37; LILLJ., *Sv.*, *Norg. Fisk.*, vol. II, p. 202.

Gadus Lubb, EUPHRASÉN, Vet. Akad. Handl. 1794, p. 223, tab. VIII.

Brosmus vulgaris, FLMNG, l. c.; STORER, (*Brosmius*), *Rep. Ichth.*, *Herpet. Mass.*, p. 136; KR., *Danm. Fisk.*, vol. 2, p. 215; NILSS., *Skand. Fn.*, *Fisk.*, p. 597; MGRN, *Finl. Fiskfn.* (disp. Helsingf.), p. 31; OLSEN, *Piscatorial Atlas*, No. 21.

Brosmius flavescens, LESUEUR., *Mem. Mus.*, tom. V, p. 158, tab. 16, fig. 2; GTHR, *Cat.*, l. c.

Brosmius americanus, GILL., Proc. Acad. Nat. Sc. Philad. 1863, p. 242.

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[a] LEEM, *Lapp.*, p. 327; STRÖM, *Søndm.*, vol. I, p. 272, tab. I, fig. 19.

[b] OLAFSEN, *Reise Isl.*, vol. I, p. 358, No. 6.

[c] PENNANT, *Brit. Zool.*, tom. III (1776), p. 178.

[d] *Règne Anim.*, ed. I, tom. II, p. 216. In the second edition of this work (1829), tom. II, p. 334, the name of *Brosmius* occurs. This name is indeed two years younger than FLEMING'S *Brosmus*, but it has come into general use.

[e] *Brit. Anim.*, p. 194.

[f] Sometimes 85, according to KRØYER.

[g] ,, 62, ,, ,, ,,

[h] ,, 19, ,, ,, ,,

According to STORM the Torsk attains a length of a metre or more. LOW says that the largest specimen he ever heard of, was $3^{1}/_{2}$ ft. (1067 mm. long). The fish is capable, however, of reproducing its species at a length of 3 dm., and it is only exceptionally that specimens more than 8 or 9 dm. long are found.

In the form of the body the Torsk is most like a Rockling, being less elongated than the Common Ling, fairly terete in front, but strongly compressed at the tail. The depth of the body at the beginning of the anal fin in young specimens (2—3 dm. long) is about 15 %, in older ones (4—$6^{1}/_{2}$ dm. long) about $17^{1}/_{2}$ %, of the length of the body. The depth of the tail across the base of the first caudal rays in young specimens measures about $5^{1}/_{2}$ % of the length of the body, in older ones about 6—$6^{1}/_{2}$ % thereof. The body is broadest as a rule across the gill-covers, its greatest breadth in young specimens being about 14 %, in the oldest about 12 %, of its own length.

The head is of about the same size as in the Coalfish, larger than in the Rocklings, but considerably smaller than in the Tadpole Fish. Its length in young specimens is about 25 % of that of the body, in old about 24—$23^{1}/_{2}$ % thereof. It is of a wedge-shaped (four-sided prismatic) form, the upper contour sloping more evenly and less sharply than the lower. The forehead is flat, the occiput and snout are slightly more convex, and the sides almost vertical, though they diverge slightly in a downward direction. The snout is moderately broad, its anterior margin rounded (horizontally) and projecting slightly beyond the upper or the lower jaw. The eyes are set fairly high, their upper margin being nearly on the same plane as the forehead, and turned slightly upwards, on the same plane as the cheeks. Their size is moderate for a Codfish, their longitudinal diameter in young specimens measuring about $5^{1}/_{2}$ %, in the oldest about $3^{1}/_{2}$ %, of the length of the body, or respectively about $21^{1}/_{2}$ and $14^{1}/_{3}$ % of the length of the head. Their position is such that the length of the snout varies between about $7^{3}/_{4}$ and 7 % of that of the body or about 30 % (29·2—31·3 %) of the length of the head, and the postorbital length of the head between about 12 and 13 % of the length of the body or about 50 and 55 % of the total length of the head. The interorbital space is flat and rather broad. Its breadth in young specimens is somewhat less, in old considerably more, than the longitudinal diameter of the eyes. This breadth also varies in different individuals between 5 and 6 % of the length of the body or 20 and 26 % of the length of the head. The nostrils are rather small. The anterior nostril, with its hind margin raised into a canaliculate lid, is set somewhat behind the middle of the snout, the posterior, which is somewhat larger and oblong, about half-way between the anterior nostril and the eye, and both on about a level with the middle of the eye. The mouth is turned slightly upwards and middle-sized for a Codfish. The length of the upper jaw from the tip of the snout to the hind extremity of the maxillary bones measures about 12—11 % (11·8—10·9 %) of the length of the body or 48—46 % (48·3—45·7 %) of that of the head; and the length of the snout is less than $^{2}/_{3}$ (62—65 %) of that of the upper jaw. The length of the lower jaw is somewhat greater than either the postorbital length or the greatest breadth of the head, though in young specimens it is equal to the latter. It measures about 14—$13^{1}/_{2}$ % of the length of the body or 61—56 % of the length of the head. The lips are fleshy and mobile. The upper jaw-bone may be concealed to a great extent, when the mouth is closed, under the dermal fold that hangs down from the margin of the suborbital bones. About half-way along the upper jaw, somewhat in front of the end of the intermaxillary bones, we find a protuberance, which is chiefly composed, however, of cartilage, on the upper jaw-bone. The teeth are pointed and curved, and in the jaws form well-developed cards, broadest in front, growing narrower behind (in the lower jaw to such an extent that the card ends in a single row), the intermaxillary teeth being of fairly uniform size, those of the lower jaw largest in the innermost (hindmost) row. On the head of the vomer they form a semicircular or angular band, narrow, but in the transverse direction of the palate long, and consisting of two or three rows, the last (innermost) row with the largest teeth. The tongue is fleshy, bluntly pointed, and, like the palatine bones, toothless. The pharyngeal teeth are of the same form as the jaw-teeth, and form above, on each side, two transversely set cards (the two hind pharyngeals are united), the anterior narrow, the posterior almost semicircular. The lower pharyngeal cards, one on each side, are oblong and lanceolate, growing narrower, as

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[a] *Faun. Orcad.*, p. 200.

usual, behind (outwards). The gill-rakers are short and scattered — about 13 in number on the first branchial arch, but the foremost (lowest) and uppermost ones hardly distinguishable — tubercular and spiny. The branchial arches are complete, but the fourth (hindmost) is united throughout the greater part of its length to the hind wall of the branchial cavity, the last gill-slit thus being rather small. The mouth is without transverse folds (vela). The barbel under the chin is equal in length to the longitudinal diameter of the eye or even longer[a]. The branchiostegal membranes are united below for a great part of their breadth. Their hind margin forms a fairly regular curve, without distinct opercular flap. The whole gill-cover is imbedded in the skin; and the gill-opening does not extend to its superior margin, the upper corner of the gill-opening lying on about a level with the middle of the eye.

The dorsal fin begins at a distance from the tip of the snout equal to about $27^1/_2$—$25^3/_4$ % of the length of the body, and thus moves forward with age, while the length of its base shows even relative increase from about $61^1/_3$ % to rather more than 65 % of the length of the body. The number of the rays seems also to increase at the same time, from about 90 to 105, which latter number we have found in a fish 64 cm. long. The fin rises in a very elongated arch, its greatest height (where the length of the rays is about $9^1/_2$—8 % of that of the body) lying about $^7/_8$ of the way along the fin; but the last rays sharply diminish in length, and the fin ends in a bluntly pointed lobe, with half its hind margin coalescent with the upper margin of the caudal fin. The division between these two fins may, however, be traced internally as well, for the last ray in the dorsal fin is multifid, the uppermost ray in the caudal fin simple, as well as the first two or three rays of the dorsal fin. The anal fin is of the same structure and form as the dorsal, but not quite $^2/_3$ (61—$64^1/_2$ %) as long. It is also lower, and its union to the caudal fin shorter. It begins at a distance from the tip of the snout that measures between 52 or 53 and 51 % of the length of the body, and the length of its base seems to vary individually between $37^1/_2$ and $41^1/_2$ % of the same length. At the ends of the dorsal and anal fins the tail tapers to a point from above and below, thus forming a triangular base for the caudal fin. This fin is broadly rounded, almost as in the Burbot, and its length at the middle is in young specimens more, in old less, than the depth of the tail at the beginning of the fin. In our largest specimen, which is 64 cm. long, the caudal fin contains 46 rays, the uppermost two and the lowest two simple.

The pectoral fins are rounded and of average size or smaller, their length varying in different individuals between 12 and 10 % (sometimes $9^1/_2$ %) of that of the body. In the specimen just mentioned they are made up of 24 rays, only the uppermost ray being simple.

The ventral fins are of a more characteristic form. They are rather long, sometimes (in young specimens) longer than the pectoral fins, but narrow and of uniform breadth, this being due to the fact that the last (hindmost) ray is only slightly shorter than the first, which in its turn is a little shorter than the three middle rays, and like them projects a little way beyond the common membrane. All the rays are simple and with extremely numerous articulations, but may be easily divided in two halves throughout their length from the very base. The fins are set in about a line with the upper corners of the gill-openings, but move forward, as usual, with age, the distance between them and the beginning of the anal fin rising in adult specimens from about 28 to 31 % of the length of the body. The distance between the anterior ends of their insertions is half the length of the lower jaw.

All the fins are covered with skin, thick at the base, but growing thinner towards the margin, which renders the counting of the rays without dissection difficult and uncertain.

The scales extend over the whole body and head, except the very tip of the snout and the lips, out over all the fins, right to the thin margins, which are naked. They are linguiform, thin, and small — extremely small on the head and fins — largest, as usual, on the caudal part of the body, and everywhere densely imbricated. The largest scales in a specimen 64 cm. in length are about 5 mm. long and 2 mm. broad at their broadest point, which lies where they project from their follicles in the skin, in which they are imbedded for the greater part (about $^3/_4$) of their length. Their structure is essentially the same as that of the scales in the genus *Molua*, and they are furnished with a moniliform marking produced in the same way (see above, p. 521 and note *b*), but still more closely resemble the scales of the Eels. The nucleus is very eccentric, sometimes extremely small, but sometimes, even in the largest scales, very large. In the Torsk, as in the Eels, we find the body marked with vermiform grooves, as it were, at the spots where small scales are set in rows, for the greater part concealed in the skin, e. g. on the occiput and the front part of the back. The lateral line does not pierce any scales; but most of the scales that lie under or nearest its pores are more or less irregular and oblique. Still, it is fairly distinct, with its ramified pores, especially in front, where, on the abdominal part of the body, it runs in a very long arch from the posttemporal region, above the gill-cover, to a point some way behind the perpendicular from the beginning of the anal fin. It then runs fairly straight or with a number of angular sinuations, along the middle of the side to the tip of the base of the caudal fin.

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[a] In our youngest specimen much shorter.

The coloration in old specimens is light gray with a dash of chocolate colour, growing paler downwards and shading into the grayish white colour of the belly. The fins at the base are of the same colour as the body, but out towards the margin on all the vertical fins this colour is interrupted by a black band, which at the extreme margin is exchanged for white, pure or with a slight yellowish tinge. These black and white bands are broadest on the dorsal and caudal fins and on the hindmost part of the anal fin, narrowest on the rest of the anal fin. The pectoral fins are to a greater or less extent yellowish, the ventral blackish at the top. The iris is bronze-coloured on a silvery white ground. In young specimens the yellowish colour also extends to the body and the bases of the vertical fins, on each side of the body in the form of five or six broad, more or less sharply defined, transverse bands, one of which lies under the pectoral fin. In this coloration we find a distinct resemblance to the Lings, though the juvenile characters are here much more persistent, just as in the structure of its fins the Torsk proves to be a far less differentiated (more original) form than the Lings.

In the internal organs there is no essential difference from the other Codfishes. The abdominal cavity extends back to a line with about the seventh ray of the anal fin. The air-bladder is long and thick-walled, firmly united to the transverse processes of the abdominal vertebræ. The pyloric appendages are rather few: Lilljeborg gives their number as 8, while in a specimen 64 cm. long we found 15. In this female, which was caught in August, in Trondhjem Fjord, the ovaries were thin, almost ribbon-shaped, and about half as long as the abdominal cavity, and contained almost microscopically small eggs.

In the cranium we remark the flat forehead and occiput, with the occipital ridge as it were flattened at the upper margin and extended on the same plane as the top of the head, which behind (at the occipital surface) is as it were suddenly cut short at right angles, the squamosal bones (*ossa pterotica*) projecting only slightly further back than the mastoid bones (*ossa epotica*). The former bones send out, forwards and inwards, converging towards the middle of the forehead, up to the suture between the closely united frontal bones, two broad, flattened, osseous ridges which evidently correspond to the thin osseous canals that run forward at the same spot in the Tadpole Fish, and which probably contain, like the latter, a muciferous duct. In other respects the structure of the cranium is Gadoid, but the surface of the top of the head and the occipital ridge are finely punctated in a characteristic manner with pores. The intermaxillary bones most closely resemble those of the Hake and the Tadpole Fish, but are shorter (about $^2/_3$ as long as the maxillaries), the lobate process, which has the same form and lies in the same backward direction as in these two species, rising above the posterior third of the bone, and extending almost as far back as the bone itself. In the gill-cover apparatus the operculum is of the Gadoid type, with an angular incision at the hind margin; but the lower corner is the more elongated and the stronger, in which respect the Torsk is the direct opposite of the Tadpole Fish, where the upper corner of the operculum (which is itself remarkably long) is greatly elongated and pointed. The pelvic bones are composed chiefly of the two terete prongs, which meet at a somewhat obtuse angle, behind which lies the thin, osseous lamina with articular surface for the rays.

The Torsk (Sw. *Lubben* = Lubber) has long been taken with long-lines on the coast of Norway together with Halibut and Ling. Thus it probably leads essentially the same life and lives generally at the same spots as these fishes. It occurs in the same manner off Iceland and on the north-east coast of North America, according to Brown-Goode, from lat. 65° to 42° N. The Swedish Royal Museum possesses a specimen from Greenland, probably from Claushavn. Whether the species occurs off Spitzbergen — as has been stated and as seems highly probable — is a point on which we can offer no evidence: it has not been found there by any of the Swedish expeditions. In the East Atlantic it is common south to the Shetland Islands, a little less so off the Orkneys, and occurs at least on the coast of Yorkshire, according to DAY; but whether it has really been found on the Irish coast, is doubtful. Thus the limits of its range lie here, as BROWN-GOODE has remarked, between about 80° and 55° N. lat. On the coast of Sweden it has been met with off Bohuslän alone, to which locality it was assigned by EUPHRASÉN, but only as rare. Mr. C. A. HANSSON has forwarded to the Royal Museum a specimen 5 dm. long that was taken off Hökö in August, 1888. During thirty years MALM obtained only three specimens on the coast of Bohuslän. One of these, a specimen 36 cm. in length, was taken about 6 miles west of Vinga, the most southern latitude at which this fish has yet been found in Sweden. KRØYER records an observation made by BOIE according to which the species has been taken off Ferringsö on the west coast of Jutland.

The Torsk is, therefore, a northern deep-sea fish, though it cannot rank as one of the most prominent of these forms. According to MALM it is found on the coast of Bohuslän only "on a firm bottom in deep water, between 30 and 80 fathoms in depth." The most productive fishing-banks on the Norwegian coast lie in about 100—200 fathoms of water, and here the Torsk lives in the coral-groves (*Gorgoniæ*). The English *Knight Errant* Expedition found the species in Faroe Channel at a depth of 530 fathoms. After violent storms the Torsk is often cast ashore or seen drifting helplessly about at the surface, like so many other deep-sea fishes, when from some cause or other they have ascended higher than the level to which they are accustomed, and been carried up with too great velocity to permit of their adapting their specific gravity to the new conditions. STRÖM writes on this point: "Besides it is known that the Torsk has a much weaker head than other fishes, and is, therefore, easily thrown into a swoon. Thus, during a violent storm or a so-called *ground-swell* it may be often seen lying in a stupor at the surface, and on this account such weather is known here as *Brosme-Før* (Torsk fare, i. e. weather)."

In Scandinavian waters the Torsk is never taken in sufficient quantity to rank beside the large catches of Cod. But that this species is also gregarious appears from BROWN-GOODE's statement, for example, that one single Provincetown-firm has taken about 60,000 lbs. of Torsk in one year.

This fish is caught with long-lines and hand-lines. When it feels that it is a prisoner, it is said, like the Eel, to coil itself round any object within its reach, and is sometimes extremely difficult to draw up. The hook is baited with Herring, or mussel and other shell-fish. The stomach of the Torsk, however, most often contains crustaceans, which thus seem to be its principal food. In most cases, however, the stomach, empty and turned inside out, hangs from the mouth like a red bladder, in those specimens which are suddenly drawn up from great depths.

Early in the year, says FABER, the Torsk makes its way towards the land, off Iceland even in January, and stays there in company with the Five-Bearded Rockling. Late in summer it returns out to sea. The spawning-season occurs in April and May, according to FABER and KRØYER as well. This statement is also borne out by the fact we have noticed above, that in the autumn an adult female had rather small ovaries.

Its qualities as an article of food are disputed, but are at least not much inferior to those of the Cod. "Its flesh is firm, white, and of good flavour," writes EUPHRASÉN, "but rather fat" (others find it too hard) "and has some similarity in taste to lobster or crab, which animals undoubtedly form the chief portion of its food." In Norway it is not only consumed fresh, but also cured in the form of stockfish, and round fish, among which it is exported to other parts of the world. The roe is good; and the liver yields a fine oil, which, according to FABER, is an efficacious remedy for burns and rheumatism.